REGION/ORD/OAR WORKSHOP ON AIR TOXICS EXPOSURE ASSESSMENT

SUMMARY REPORT

June 25 - 27, 2002
San Francisco, California

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

FOREWORD

The *ORD/OAR/Regional Training Workshop on Air Toxics Exposure Assessment* was the tenth in a series of Regional Science Topic Workshops sponsored by the Office of Science Policy (OSP) in the Office of Research and Development (ORD) at the United States Environmental Protection Agency (EPA). Other workshops in this series included:

- *Asthma: The Regional Science Issues*
- *Communicating Science: Waves of the Future Info Fair*
- *Fully Integrated Environmental Location Decision Support* (FIELDS)
- *Non-Indigenous Species*
- *Pesticides*
- *Endocrine Disruptors*
- *Emerging Issues Associated with Aquatic Environmental Pathogens*
- *Aquatic Life Criteria*
- *Critical Ecosystems*

The objectives of the Regional Science Topic Workshops are to: 1) establish a better cross-Agency understanding of the science applicable to specific region-selected human health and/or ecological topics, and 2) develop a network of EPA scientists who will continue to exchange information on these science topics as the Agency moves forward in planning education, research, and risk management programs.

Each year, EPA regions identify priority science topics on which to conduct workshops. The workshops address the science issues of greatest interest to the regions on the selected topic area. Each workshop is planned and conducted by a team of regional, ORD, and interested program office scientists, is led by one or more Regional Science Liaisons (RSLs) to ORD, and is facilitated by a regional chairperson. Participants maintain the cross-Agency science networks they establish at the workshops through planned post-workshop projects and activities such as identifying collaborative research opportunities, creating information sharing mechanisms (e.g., interactive web sites), and developing science fact sheets for regional use.

For additional information on a specific workshop or on the Regional Science Topic Workshop series in general, contact David Klauder in ORD's Office of Science Policy (202-564-6496).

THIS PAGE INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The *ORD/OAR/Regional Training Workshop on Air Toxics Exposure Assessment* was held on June 25 - June 27, 2002, in San Francisco, California. The workshop was chaired by Winona Victery (Region 9) with support from David Klauder (ORD/OSP).

The workshop was organized into six sessions:

I. Designing an Air Toxics Exposure Assessment – Monitoring vs. Modeling
II. Monitoring Methods and Network Design
III. Modeling Tools – Current and Future
IV. Human Exposure Assessment
V. Source Apportionment
VI. Communicating the Results and Workshop Conclusions

The workshop focused on two general exposure assessment questions:

1. What is our inhalation exposure to toxic chemicals of concern in our regions (at a "screening level of certainty")?
2. What is our inhalation exposure to toxic chemicals of concern in our community (at a "high level of certainty")?

Scientists from EPA (regions, Office of Research and Development, and Office of Air and Radiation) and invited speakers from private industry, academia, and state agencies presented methods, current research, and case studies on monitoring and modeling, human exposure, and source apportionment. Two breakout sessions focused on designing an air toxics monitoring network (Session II), and an in-depth discussion of several topics related to modeling (Session III). Participants also took part in an interactive exercise designed to simulate a real-world problem to be solved by weighing the advantages and drawbacks of both modeling and monitoring, as well as communicating the results. The last session included a presentation on effectively communicating the results of air toxics exposure assessments to the public. The closing remarks and discussion at the end of the workshop generated a list of action points and potential workshop outcomes (see Session VI). Planned outcomes include posting of presentation slides and workshop summary on the OSP internet site. Most participants found the workshop useful according to the workshop evaluations; many expressed a need for methods and tools, training, improved communication, and sharing of data, results, and tools application.

THIS PAGE INTENTIONALLY LEFT BLANK

INTRODUCTION

Welcome: Jack Broadbent (Region 9) and Larry Cuppitt (ORD/NERL)

Workshop Goals/Logistics: Winona Victery (Region 9)

***PLEASE NOTE**: Slides from the Workshop presentations are available at:*
http://epa.gov/osp/regions/workshops.htm

Introductory Remarks – Jack Broadbent (Region 9)

Jack Broadbent began the workshop by welcoming the participants and speakers, and emphasized the increasing public concern regarding the subject of air toxics. Implementing a strategy for urban air toxics is a top EPA priority. To implement such a strategy, it is necessary to understand how to perform exposure assessments and interpret their results; how to incorporate modeling and monitoring in conducting such assessments; and how to communicate assessment results to the public. The workshop also provides a valuable opportunity to meet persons from across the Agency that are involved in the field of air toxics.

Air Toxics Exposure Assessment Workshop – Welcome – Larry Cupitt (ORD/NERL)

U.S. EPA Administrator Christine Whitman has emphasized the importance of using sound science for Agency decisions. Science Topic Workshops are part of the Office of Research and Development's (ORD) Regional Science Program. Up to three such workshops are held annually, on topics chosen by the regions. The regions, ORD, and interested program offices all participate on the workshop planning teams. Recognized as an effective way to understand the state of the science and identify regional science needs, these workshops also help build liaisons for information exchange and reveal opportunities for integration and collaboration. Specific objectives of the Regions/ORD Science Topic Workshops include:

- Creating cross-Agency science networks;
- Providing opportunities to integrate EPA science into regional decision-making; and
- Identifying critical science uncertainties and needed science products.

Sound science is critical to understanding how emissions, ambient conditions, exposures, and ultimate impacts are linked. Air toxics exposure assessments provide information for EPA to decide whether to take action, to determine which actions will be most effective, and to provide a measure of success of the actions taken. Exposure science, however, also presents some challenges. The need to track exposure data is recognized, particularly as more data (e.g., on bioindicators) continues to become available. EPA also needs to know more about exposure. These challenges can be met with an aggressive program to make the data useful in protecting both human health and the environment. In addition, the available indicator data should be augmented with information on hazards associated with the exposure, sources or pathways of exposure, and scientifically credible actions to mitigate both exposure and effects.

Overview of Exposure Assessment and Air Toxics – Ken Mitchell (Region 4)

The mission of the EPA is to protect human health and to safeguard the natural environment upon which life depends. To accomplish this mission, EPA strives to ensure that all Americans are protected from significant risks to human health and the environment where they live, learn, and work. Exposure to air toxics can occur at two different scales (national/regional and community); assessments should take both of these scales into account. Air toxics are a significant potential risk because they may cause health effects, disperse from one location to another, persist and/or bioaccumulate, and have multiple potential routes of exposure. In addition, little is known about risks from exposure to air toxics. The Clean Air Act (CAA) lists 188 hazardous air pollutants (HAPs), but it is likely there are other chemicals that are not yet recognized as air toxics. The National Air Toxics Assessment (NATA) provided a national-scale estimate of cancer risk due to thirty-three priority urban air toxics. Although emissions have decreased in the last ten years, median cancer risks are still relatively high throughout the country – from less than one per million to more than a hundred per million. Indoor air quality must also be considered; indoor air can be more polluted than outdoor air, and most people spend the majority of their time indoors.

Multiple programs and initiatives exist that address air toxics; dose-response assessment and exposure assessment are particularly important in characterizing overall risk. Human exposure to air toxics occurs any time there is contact with a chemical; some examples of exposure routes are inhalation, ingestion, and uptake (absorption) through the skin or eyes. Each exposure results in a dose, or the amount of chemical that reaches the external barrier (applied dose), crosses the external barrier (internal dose), reaches an individual organ/tissue (delivered dose), or reaches cells/membranes to cause adverse effects (biologically effective dose) [slides 17, 18].

Chemical contact, uptake/intake rates, pathways and routes of exposure, and the potential and absorbed dose can all be estimated by exposure assessment. Mathematical formulas were presented for calculating risk [slides 22, 23]. The effective concentration ("C" in the risk equations) can reflect chronic exposure (low level exposure over long periods of time) or acute exposure (high level exposure over a short time). Chronic and acute exposure often exhibit different effects. Cumulative exposure is also important, and provides a more complete approach than measuring individual sources; it is often measured at the personal exposure level.

Assessments can be conducted at different scales; risk is found to be higher, in general, in studies done at low levels of geographic scale. Risks are likely much higher in specific places than estimated by the national assessment, and risk vary from one person to another. As a result, assessment goals have to be carefully defined to determine which level of assessment is needed.

Finally, uncertainties exist at every step of the exposure and risk assessment process, and must be considered in the analysis of results.

Overview of Air Toxics Exposure Assessment in ORD – Tim Watkins (ORD/NERL)

Tim Watkins updated participants on current and planned ORD research in the area of air toxics exposure assessment. A diagram [slide 2] illustrated how the five ORD laboratories align with the risk assessment/risk management paradigm. The air toxics research program is based on the Air Toxics Research Strategy (ATRS) and the Air Toxics Multi-Year Plan (MYP). Both these documents are undergoing peer review and will be publicly available in the near future. The ATRS outlines the key questions addressed by exposure assessments, and the MYP defines clear research goals and serves as the implementation tool for the ATRS.

ORD air toxics exposure assessment activities include research in four main areas:

Source characterization characterizes emissions from sources of air toxics and identifies source contributions of measured concentrations. ORD is currently measuring emissions to be used in developing emission factors and source profiles; these will eventually help to improve emissions inventories. Source apportionment models are also being developed for use in deriving source apportionment data and tools.

Research is also being conducted on several aspects of **atmospheric fate**. In the field of atmospheric chemistry, the current focus is on characterizing the chemical and physical processes that impact the fate of air toxics. Literature is being reviewed to determine the chemical mechanisms for the thirty-three urban air toxics, and will ultimately yield chemical algorithms for incorporation into air quality models. The Community Multiscale Air Quality (CMAQ) Modeling System was developed in response to a need for a modeling system that estimates the dispersion and deposition of air toxics at multiple scales (for additional information and CMAQ website see the summary of Session III in this report). Benzene, formaldehyde, acetaldehyde, mercury, and dioxin will be incorporated into CMAQ in the near future, and one or two additional air toxics will be added each year. Measurements of ambient concentrations of persistent toxics are also used to characterize atmospheric processes that affect the fate of air toxics. High altitude mercury monitoring, and the National Dioxin Air Monitoring Network (NDAMN) are two current activities in the area of atmospheric measurements. Data will be used to understand the fate and long range transport of persistent toxics, and to incorporate into atmospheric models. In addition, measurement methods are being refined and new methods developed for measuring air toxics, both in ambient air and for human exposure studies (for additional information on air toxics measurement methods see the summary of Session II in this report). The method for measuring acrolein and other carbonyls will be available in the near future and will be used in the air toxics ambient monitoring network.

There is also ongoing research in the area of **personal exposure** to characterize the relationships among ambient, outdoor, indoor, and personal concentrations, to identify the factors which influence personal exposure, and as a means of measuring indirect exposures to persistent toxics. Current work includes both measuring and modeling human exposure to air toxics, as well as measuring concentrations of persistent toxics in food. Once data have been collected they will be added to the National Exposure Research Laboratory's (NERL) Human Exposure Database System (HEDS) (for additional information on HEDS see the summary of Session III in this report).

Dose-to-target tissue studies are also underway to better characterize exposure-dose-response relationships, and to incorporate those relationships into dose modeling. Results will be used in dose response assessments and in the development of an integrated "source-to-dose" human exposure model.

The importance of matching reported health effects to exposure information was emphasized, as incompatible exposure and health information can impair risk assessment. Exposure assessment should consider the health risks of concern – e.g., acute vs. chronic effects, or reproductive effects. Diagrams were presented to show the impacts and relevance of ORD's exposure assessment research [slide 16] and to illustrate the design, progress, clients, outputs and goals/outcomes of ORD's air toxics research program.

Watkins concluded by stating that this workshop would be a valuable opportunity to provide information on ORD's research to clients and end users, and to connect with regional scientists to gain a better understanding of their exposure assessment research needs.

SESSION I: DESIGNING AN AIR TOXICS EXPOSURE ASSESSMENT – MONITORING vs. MODELING

Co-chairs: Ken Mitchell (Region 4), Paul Shapiro (ORD/NCER), and Ted Palma (OAR/OAQPS)

Paul Shapiro introduced the first session as an opportunity to give participants a way of viewing air toxics problems in context, and addressing the issues of monitoring and modeling. The Air Research Coordination Team (RCT), headed by Bob Fegley (ORD/OSP), meets and plans throughout the year; the RCT welcomes regional involvement in prioritizing science. The website for the National Center for Environmental Research (NCER) is another useful resource:

http://www.epa.gov/ncer

Shapiro also indicated that the case studies file provided in the binder would become a "living document" and a resource for participants to be used beyond the end of this workshop. Finally, he informed participants that Session I would begin with an interactive exercise, then proceed to presentations of case studies, and end with an expert panel discussion.

Monitoring vs. Modeling – An Interactive Group Exercise – Paul Shapiro (ORD/NCER) and Ted Palma (OAR/OAQPS)

An overview of modeling and monitoring outlined the typical usage, purposes, and strengths and weaknesses of both techniques, and several points to consider when deciding which technique to use.

The problem scenario presented was an increase of nasal and lung irritation and headaches in a populated community located near a newly built highway and a chrome electroplating facility. A map [slide 8] illustrated specific locations, relative distances, and the direction of prevailing winds. Five randomly selected participants represented a planning team consisting of a monitoring expert, a modeling expert, a meteorologist, a community relations expert, and a data analyst. The planning team was allotted a budget of $100,000 to address the problem and a time frame of ninety days, after which a community meeting would be held. The planning team was also given a price list for services provided by a fictional environmental consulting company ("S&P"), and was tasked with deciding on a combination of modeling and monitoring services based on their budget, time frame, and goal for the assessment.

At the end of their allotted time, the planning team met with a community reaction panel, comprised of five other randomly chosen participants and consisting of: the mother of a child with asthma; a City Council Member; a hospital director; the owner of the chrome plating

company; and a representative from a community environmental organization. Following the simulated "meeting", the community members filled out a community scorecard to rate their satisfaction with the planning team's assessment and communication of results. The results of the "scorecard" are presented below:

	1 (low)	2	3	4	5 (High)
1. Confidence Identified Problem			X		
2. Allayed My Fears		X			
3. Know Who Is At Risk	X				
4. Know What to Do to Protect Them	X				
5. Know How to Control Problem	NA				
6. Was modeling data adequate to satisfy your needs		X			
7. Was Monitoring data adequate to satisfy your needs			X		
8. Was balance of Monitoring and Modeling appropriate				X	
9. Know Next Steps	X				
10. S&P Earned Their Fee		X			

Conclusions from the exercise emphasized that each situation is unique, and that competing needs and interests, limited resources, and varying technical capabilities all play important roles in real-life scenarios. As evidenced by the simulated community meeting, communication of results to the public can be as important as the science. Participants were reminded to keep these issues in mind throughout the remainder of the workshop.

Case Studies to Illustrate Uses of Monitoring and Modeling

MATES II – A Regional Perspective – Mike Nazemi (South Coast Air Quality Management District)

The results of the Multiple Air Toxics Exposure Study (MATES II) were presented. South Coast Air Quality Management's (AQMD's) governing board adopted guiding principles in 1997, and established a set of environmental justice initiatives [slides 3,4]. The MATES II study was conducted as part of the "ambient monitoring of air toxics initiative" and was a follow-up of MATES I, a similar study conducted a decade ago. There are three principal components to MATES II: 1) toxic air contaminant monitoring in ten fixed locations in the South Coast Air Basin; 2) a Basin-wide emissions inventory, developed for 1998; 3) dispersion modeling and risk assessment, used to construct a full-Basin picture of inhalation risk. A panel of experts from academia, environmental groups, industry, and government agencies served as a review board and provided technical direction for the study.

Monitoring was conducted for one year at ten sites, based on EPA Guidelines (*Neighborhood Scale Monitoring*). Additional sampling was done in fourteen communities using mobile monitoring platforms. In all, thirty toxic pollutants were measured. The locations of monitoring sites, equipment used, a complete list of chemicals monitored, and the laboratory procedures used for analysis were reported [slides 9-12]. Results from MATES II, when compared with MATES I, indicated that cancer risks in the Basin have decreased dramatically over the last ten years [slide 10]. Three monitoring sites common to both studies were used for comparison: Los Angeles (LA), Long Beach (LB), and Rubidoux (RU). Only pollutants common to both studies were included in calculating accumulated risks. Cancer risks since MATES-I have decreased by 76% in Los Angeles, by 73% in Long Beach, and by 55% in Rubidoux. These and similar risk results in other Basin locations were illustrated in slides 13 through 21. Cancer risks for each location were also aggregated into stationary and mobile sources, highlighting the importance of diesel particulate to the total inhalation cancer risk [slides 22-25]. Seasonal variation was shown to be significant in risk levels attributed to mobile sources, but not in those from stationary sources [slides 26, 27].

The MATES II emissions inventory included on-road mobile sources, area and off-road mobile sources, and more than 2,588 major point sources. The Direct Travel Impact Model (DTIM) was used to provide hourly gridded emissions and speciation profiles. Stationary sources' emissions information was collected from Annual Emissions Reporting and from toxic hot spots, and allocated spatially and temporally. Dry cleaners, gasoline stations, auto body shops, and chrome platers were the most important contributors to stationary source emissions. Locations of these facilities in the Basin were correlated with emissions of perchloroethylene, benzene, and

hexavalent chromium [slides 32-45]. Results were presented by species and by source [slides 46-49], both with and without diesel particulate matter (the most significant factor in toxic emissions). Distribution of diesel emissions plotted on a Basin map revealed high concentrations along roads and shipping lanes [slide 50]. Annual average day emissions were summarized for diesel particulate matter, benzene, and 1,3, butadiene for on-road, off-road, and stationary sources [slide 51].

Meteorological and dispersion modeling were used to model concentrations, and risk assessment estimated the cancer risk from nearly thirty air toxics in a simulation of a full year. Model performance was checked against measured concentrations for gases and particulates [slides 58-59]. Office of Environmental Health Hazard Assessment (OEHHA) unit risk factors (URFs) were used, and assumptions included a seventy-year lifetime exposure by inhalation risk only, and the premise that cancer risks are additive. Model results, presented on a map [slide 61], indicated higher cancer risk in the south-central Los Angeles area, the harbor area, and near freeways. The model results were similar to monitoring results in their estimates of cancer risk, and in attributing a high percentage of that risk to mobile sources [slides 62, 63]. The model generally exhibited an under-prediction bias, possibly due to underestimated on-road emissions. Nearly ninety percent of the cancer risk was attributed to diesel particulate matter (PM), benzene, and 1,3, butadiene (combined). Mobile sources accounted for more than 98%, 90%, and 95% of the diesel PM, benzene, and 1,3, butadiene, respectively. The modeling study demonstrated that regional modeling tools can be effectively used for a regional risk assessment.

A micro-scale monitoring study was also conducted in an attempt to capture “hot spots” not evident by the fixed monitoring, to confirm hot spots revealed by modeling, to respond to public concerns, and to assess to what extent monitoring was locally representative. Consistent with the MATES II study results, diesel and other mobile sources are the dominant contributors to inhalation cancer risk. In one site (Anaheim), local emissions of styrene were considerably higher than predicted by the model; three styrene-emitting facilities were found to be nearby, although outside the area considered by the model. A strategy was proposed for directly or indirectly controlling the emissions of air toxics, and model results were presented predicting the impact of its implementation [slides 73, 74].

Uncertainties inherent in the MATES II and micro-scale studies included the indirect measurement of diesel PM, determination of risk values, laboratory and measurement processes, and model inputs and computational algorithms. However, analysis of the results to reveal sensitivities to methods and to diesel PM toxicity showed a consistent pattern [slides 81, 82].

Questions and Comments

Question: How did you get the numbers presented on the last slide [Species Apportionment – Sensitivity to Diesel PM Toxicity]?
Response: By doing a comparative analysis using weighted emissions of the different pollutants.

Question: Why did the model not work in Anaheim?
Response: A group of experts chose the site to be used for modeling, and determined a "wedge of influence" for known emissions sites. In this case, the sites responsible for the styrene emissions were outside this wedge of influence, yet it was found that they were contributing to area emissions.

Question: Have you thought about gasoline particulate matter (PM)?
Response: Gasoline PM was not measured, so we do not have any information on it.

Question: Did you look at non-cancer endpoints?
Response: No, they were not considered in the study. The study was limited by the available toxicity data.

Minneapolis - St. Paul – A Comparison of Community, Residential, and Personal Exposure – John Adgate (University of Minnesota)

A study performed in the Minneapolis-St.Paul area compared outdoor, indoor, and personal exposures to particulate matter ($PM_{2.5}$) volatile organic carbons (VOCs), and compared model results with the monitoring results. The presentation focused on VOCs, as there are no results yet for the $PM_{2.5}$ study. Three neighborhoods, each with PM and VOC canister monitoring sites, were used in the study; personal monitoring was conducted with organic vapor badge monitors worn by seventy subjects (non-smokers). Several toxics were measured by badges and monitoring sites, and/or were modeled [slide 7]. EPA's Industrial Source Complex (ISCST3) model was used for air dispersion modeling, along with meteorological data. Modeled times were fifty-eight 48-hour periods, to correspond with the measurements, and modeling scale was at the census tract level.

Point sources, mobile sources, and area sources were modeled. Point sources were major stationary sources that were inventoried individually; emissions of eighty-two pollutants from these sources were modeled using the Region Air Pollutant Inventory Development System (RAPIDS) database. On-road and non-road mobile sources were modeled using traffic and road data by census tract and emission factors from RAPIDS. Emissions were assigned to census tracts, and modeled as area sources. Rail and air mobile sources were also considered by apportioning airport-related and rail emissions from RAPIDS to census tracts near the airport and along rail lines. Detailed lists of the specific area source categories were presented [slides 13, 14]. A summary of the emissions inventory values for point source, mobile source, and area source emissions showed the mobile sources to be dominant, followed by the area sources [slide 15]. Benzene emissions were also illustrated on maps of the three neighborhoods, with the locations of major point sources and of the study participants' homes superimposed [slides 15-18]. Modeled benzene concentrations in the three neighborhoods [slides 19, 20] showed the highest values as well as higher variability in the Phillips area – the one surrounded by the most highways (see map on slide 17). Sources used for modeling benzene concentrations were dominated by mobile sources (89%) [slide 21]. Overall, personal benzene levels were higher than indoor levels, which were higher than outdoor levels [slide 22]. Modeled benzene concentrations were also compared to measurements by all four measuring techniques/types for all three neighborhoods [slides 23-26]. The ISCST3 model reasonably predicted outdoor VOC concentrations in two of three communities, likely because the emissions inventory is more accurate and/or the area sources less complex. The model was less reliable in the Phillips neighborhood, where mobile sources dominated. The model appears to over-predict low concentrations and under-predict high concentrations. And, as expected, it fails to predict the high VOC concentrations found in indoor and personal air.

Questions and Comments

Question: Did you consider emissions from apartment buildings?
Response: Yes, but we do not know what these show.

Question: Why were personal exposures greater than both indoor and outdoor air concentrations?
Response: People are exposed to a lot of VOC sources (e.g., when driving, using consumer products, hobby products) and are in close proximity to those products while using them. This "personal cloud" effect was also obvious in the PM experiment.

Comment: As an example, a very high exposure in one study was attributed to chemicals used by that person while making jewelry.

Comment: Personal peaks should be considered to determine health effects levels for VOCs.
Response: Yet we still get one number for the whole year from emissions inventories; this is the major challenge to the inventory data.

Question: What do you propose adds to the outdoor contribution [to make indoor and personal levels so much higher]?
Response: Personal activities; for example, covered garages and cigarette smoking are two of the major sources.
Comment: Cigarette smoke can be a big contributor even as second-hand exposure.

Question: How did you use the badges to get better detection limits?
Response: The badges are standard 3M™ badges; however, the analysis done by our lab is different, and can give much lower detection limits.

Question: Do you take repeat measurements, and what variation did you observe between repeat measurements?
Response: We do have repeat measurements, but have not yet finished the analysis to determine the amount of variation between them.

Question: Was the personal sampling non-working exposure?
Response: There was some working exposure, since the badges were worn for forty-eight hours each time. Some people showed significant work exposures, particularly for PM.

Question: What is your opinion of where the Clean Air Act is heading, especially since it is focused on outdoor air? Can we extrapolate this to the nation as a whole using monitoring or modeling?

Response: We need both processes; right now we are trying to track indoor vs. outdoor exposure over time.

Question: Do you plan to do any spatial extrapolation, i.e., will you extrapolate from your three areas, or were you interested only in those areas?

Response: A little of both; although I agree that applicability to other parts of the country is an important question.

Comment: That area is a “red spot” on the National map.

Session I Expert Panel Discussion – Mike Nazemi (SCAQMD), John Adgate (UMN), John Girman (OAR/ORIA), Larry Cupitt (ORD/NERL), Neil Frank (OAR/OAQPS), Matt Lorber (ORD/NCEA), Joe Touma (OAR/OAQPS)

John Girman (OAR/ORIA) – Monitoring and Modeling Indoor Air Toxics

Monitoring is probably used more frequently than modeling for indoor air toxics exposure assessment, since monitoring data is generally more available than model inputs. Mass balance modeling is used to analyze experimental results and to assess concentration and ventilation studies. Good mass balance models do exist for indoor air, such as the CONTAMW model developed by the National Institute of Standards and Technology (NIST), and EPA's RISK model, developed by the National Risk Management Research Laboratory (NRMRL). Many monitoring studies are also being conducted on indoor air in office buildings, schools, and residential buildings. Research needs still exist for both modeling and monitoring indoor air toxics.

Monitoring needs include:

- Study design
- Sampling equipment
- Analytical support
- Protocols
- Quality Assurance/Quality Control (QA/QC)
- Sample protocols (access)
- Time resolution

Modeling needs include:

- Models
- Ventilation rates
- Building volumes (multi-chamber)
- Activity patterns
- **Emission rates** (a big data "gap")
- Loss rates (deposition, reactions, filtering)
- Outdoor-to-indoor penetration factors

Larry Cupitt (ORD/NERL)

Exposure to air toxics consists of contact with a chemical or stressor integrated over time; chemical concentrations and sources cannot be separated from time. For some compounds, indicators exist that can estimate exposure; persistent pollutants, for example, can be measured in blood samples. Other chemicals, however, degrade or pass through biological systems very quickly.

Over the coming years there will be more of this type of data, as methods are devised to measure chemical concentration in the blood or urine. In some cases, sources can be attributed to these results from known precursors. As such tests become available, it will become necessary to explain their results to the public in terms of what the results mean and where the chemical(s) may be coming from.

Neil Frank (OAR/OAQPS) – Monitoring Tools to Support Exposure Assessment at Various Geographic Scales

The role of ambient monitoring in exposure assessment is to assess community-wide concentrations, and to quantify ambient conditions in the vicinity of localized hot spots or areas of concern (e.g., schools). There are limitations to ambient monitoring, however. Monitors do not directly estimate human inhalation exposure, and inhalation is only one of the possible exposure routes. Numerous monitoring stations may be needed to capture local structure, making cost a potential problem. Monitoring cannot give an accurate picture of exposure over time, unless combined with modeling. Ambient monitors can be used both to support models by providing data (e.g., outdoor concentrations) and to evaluate the results of dispersion and deposition models.

The design of an air toxics monitoring network should match the geographic scale of the analysis, as well as the intended data use. Regional/national scale monitoring requires representative community-wide monitoring locations; measurements of typical source impacts; and appropriate climatological and emissions regimes. A regional or national scale study should monitor year-round for one year or longer, with samples taken for twenty-four hours at intermittent intervals. Urban- or local-scale monitoring requires a higher density of sites, both community-wide and at known or suspected hot spots. Measurements can be taken year-round or for shorter periods of time, and sampling can be intermittent or semi-continuous (using less than twenty-four-hour intervals).

Maps were presented showing the location of air toxics monitoring sites across the country [slides 5, 6], although it was noted that not all of the sites run year-round, and even fewer are set to run for several years. Scatter plots demonstrated the alignment of monitoring with modeling

results for benzene, formaldehyde, and chromium [slides 7-9]. Data was also presented from ninety-five benzene sites with sufficient monitoring data to derive a national trend from 1994 to 2000 [slides 10, 11]. A significant drop in benzene emissions is evident from 1994 to 1996, illustrating another use of monitoring data: they can reveal trends to be used as surrogates for changes in exposure, and for evaluating the effects of changes in emissions regulations.

Matt Lorber (ORD/NCEA) – Comments on the Columbus Waste-to-Energy Site

Monitoring and modeling tools can be used alone or in combination to support exposure assessments. In the context of dioxin reassessment, stack monitoring and modeling have been used to conduct a risk assessment to support regulation. Monitoring includes stacks, ambient air, ash, and soil, and can be used to evaluate the relationship between stack emissions and environmental impacts. These measurements also serve to validate relevant models.

A map illustrated the positions of air and soil sampling sites in the vicinity of a dioxin-emitting facility near Columbus, Ohio. Stack emissions and on-site soil samples exhibit similar profiles, characterized by large contributions by the same three dioxin congeners. Soil samples taken off-site show a very different profile, matching the congener profile for representative background levels [slide 5].

Data from the same study was also used to validate the ISCST3 model and a soil deposition model using 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) measurements. Figures were presented showing concentration isolines near the facility as predicted by the model compared with observed values [slides 6, 7] to indicate the degree of agreement in results.

Joe Touma (OAR/OAQPS) – Monitoring and Modeling

Monitoring and modeling can be used in a complementary manner in air toxics exposure assessments, with due regards for the strengths and weaknesses of both techniques. Monitoring can be used to check the results of models, or to estimate background concentrations. Source configuration, terrain, and meteorological variations need to be considered when deciding the number of monitoring sites required. Other considerations when choosing monitoring include:

- The existence of a monitoring network for pollutants of interest, and whether it can be used at the times of concern;
- Whether the network, data reduction, and storage meet quality assurance requirements;
- Whether the network will accurately represent the impact of the most important individual source; and

- Whether there is at least one full year of data available.

Questions and Comments

Question: There is uncertainty inherent in comparisons of modeling and monitoring due to different data sets, or types of data. Have you considered combining modeling and monitoring data, instead of always using monitoring to validate the models?
Response: There was a case study in Japan that provides a good example of using the two in conjunction. A U.S. naval air facility was located near infectious waste incinerators, for which no emissions data were provided by Japan; modeling was not possible without such data. Models were eventually used only to determine where emissions monitors should be placed.
Comment: Models have also been used to determine where to look (monitor) for radon contamination.
Comment: There are higher levels of certainty when you combine a model with monitoring data; uncertainty is expected when monitoring data are not available.

Question: The Agency has QA/QC procedures in place for monitoring, but they are not available for modeling. What are the QA steps needed for a modeling study?
Response: Input data have a lot of bearing on the accuracy of model outputs, and can be used as a form of QA. Models are also evaluated using "real-world" data.
Comment: The Agency does have some QA/QC guidelines on models, but the question is whether they are sufficient.
Comment: Quality assurance is also built into every grant that we award.

Question: Since we need information on exposure, and current models are more advanced than those of a decade ago, is there any work being done to use these new models and look backwards at what exposures people might have had in the past?
Response: We do have ways of using models for "back-casting", and have done so with the emissions inventory. Resource limitations can be a problem, however, so this is not done extensively. There has not been a real need for back-casting.
Comment: The Superfund program does this regularly to estimate past exposure and determine whether it can be linked to current health effects. In Superfund sites it is not unusual for communities to ask for a back-casting, especially if health effects do exist.
Question: Are you referring to estimating, e.g., what the annual risk was fifteen years ago, or what the total risk has been since then?
Response: I was referring to cumulative risk (the lifetime exposure of a person), since incidence of disease can be predicted based on past exposure.
Comment: Almost all of us realize that we need to look at both.
Comment: As we build community assessment programs, constraints may limit us to only doing one or the other, especially at the state or local level.

SESSION II: MONITORING METHODS AND NETWORK DESIGN

Co-Chairs: Motria Poshyvanyk (Region 5), Neil Frank (OAR/OAQPS), and Tim Watkins (ORD/NERL)

Motria Poshyvanyk (Region 5) began the monitoring session by thanking the presenters and asking participants to think about the design of a monitoring study. Although monitoring data are considered "real" data, they should be examined critically, as one would with model outputs.

Air Toxics Monitoring Pilot Project – Barbara Morin (Rhode Island Department of Environmental Management)

The Air Toxics Monitoring Pilot Project is intended to help design a national network as well as to verify modeling results. EPA funded a pilot study in each of the EPA regions: four in urban areas including Providence, Rhode Island, and six in smaller cities and rural areas. The pilots were conducted for one year using a one-in-twelve days sampling frequency, standardized methods, and measuring at least seventeen specified core pollutants: nine VOCs, two carbonyls, and six metals.

The Rhode Island study used five neighborhood scale sites: an existing photochemical assessment and monitoring stations (PAMS) and $PM_{2.5}$ site and a second $PM_{2.5}$ site located in an urban area; a site adjacent to I-95; and two other sites in residential/industrial areas. Nine core VOCs and seven "max" VOCs were measured, as were 16 other VOC hazardous air pollutants (HAPs), six metals (not speciated), and three carbonyls (listed on slides 7-10). All sites were operational for one year, with two sites continuing for a second year, and one for a third year. All sites measured for all pollutants over a twenty-four-hour period every sixth day; additional sampling was done at some of the sites to capture any diurnal variations. The methods used for each group of chemicals were listed [slides 13-16]. Analysis of preliminary data resulted in a change in method for metals, since most were present in concentrations above the minimum detection limits (MDL) of a less costly method. A problem observed with metals was the presence of background concentrations in the monitors' quartz filters. Chromium had the highest background concentrations, at 55-71% – more than half of the measured concentration. Chromium also had the highest risk, assuming one hundred percent was hexavalent chromium. The mobile source site exhibited chromium levels above the cancer health effect benchmark. Carbonyl results showed little spatial variability but tended to vary seasonally; none approached the cancer health effect benchmarks. The highest-risk VOCs measured did exceed the risk benchmarks (obtained from EPA and the state of California) [slides 27, 28]; two were from mobile sources, two from background, and two from stationary sources. Benzene and 1,3 butadiene were highest at the site near the highway and lowest at the rural site.

Tetrachloroethylene reached very high levels during a six-week period in November 2001, although the reason could not be identified due to the time lag involved in processing samples. Wind direction is being considered to try to locate a source, and sector sampling may be used.

It became apparent during the course of the project that improved methods are needed to measure acrolein, acrylonitrile, ethylene oxide, diesel, and arsenic. In addition, technology that would allow continuous monitoring of formaldehyde may be useful; formaldehyde peaks came close to the short-term benchmarks for non-cancer health effects, and continuous analysis would yield more information.

Questions and Comments

Question: What was the issue with the acrylonitrile method?
Response: Many of the results did not match.

Question: Do you look at the same benchmark for all human populations?
Response: No, we really look at exposures.

Question: Were the monitors located at breathing zones?
Response: No, most were on the tops of one-story buildings, which is a little higher than breathing zones.

Question: Why do we still use the Total Suspended Particulate (TSP) method?
Response: This was part of the study's set of criteria. It can be useful if you are interested in more than the inhalation route of exposure, particularly for metals.
Comment: TSP is also relevant for measuring ecological exposures.
Comment: We should think about whether resources should continue to be invested in TSP analysis.
Comment: If we do not have a good way to use data, then there is little sense in spending resources to collect it.

Question: How high was the tetrachloroethylene peak?
Response: Between 1.0 and 1.5 parts per billion (ppb).

New Trends in Monitoring Methods – Don Whitaker (ORD/NERL)

Presented by Tim Watkins (ORD/NERL) for Don Whitaker

A significant issue in discussing current trends in monitoring methods is determining which compounds need to be monitored. The Clean Air Act Amendments of 1990 helped define these by listing 188 hazardous air pollutants (HAPs). This was further refined in the Urban Air Toxics Strategy to thirty-three compounds believed to present the greatest public health risk – known as the urban air toxics. Methods for measuring the thirty-three urban air toxics exist, although some exhibit problems such as poor sensitivity or limit of detection, stability, or recovery problems. Other methods are too costly, time-consuming, or difficult to use on a large scale basis. The Office of Research and Development (ORD) is working towards filling some of these monitoring gaps. Because of limited resources, however, research must be targeted, preferably toward multiple-use methods (i.e., methods for both ambient and personal monitoring), or those with known shortcomings. Currently, there are approximately three hundred sites nationwide collecting ambient data on selected HAPs. EPA will also be conducting air toxics human exposure studies. Three categories of issues need to be considered when assessing monitoring methods: analytical, economic, and "ease of use" issues [slides 8-10].

The plans for the National Air Toxics Monitoring network provide insight for current ambient monitoring methods needs. This is a national network planned to be completed over several years, with the objective to estimate annual average pollutant values and associated trends. Pilot sites are currently monitoring eighteen "core" volatile organic carbons (VOCs), carbonyls, and metals [slide 12]. Nine additional pollutants were also desired for inclusion, but problems with methods prevented them from being included in the "core" list [slide 14]. Current efforts in methods development are focused on three of these nine compounds: acrolein, formaldehyde, and 1,1 -dichloroethylene (DCE) (CAS No. 75-35-4) and other VOCs.

The passive aldehyde and ketone sampler (PAKS) method for acrolein was developed for personal and residential monitoring, and is a passive diffusion sampler analyzed by high pressure liquid chromatography (HPLC)-Fluorescence. Advantages of this method include improved sensitivity, reasonable cost, and better recoveries of acrolein and crotonaldehyde. Acrolein recovery is lower than desired, however, and cartridge stability needs to be improved. These problems will be addressed in proposed method development, to include field verification and comparison with the existing 2,4-dinitrophenyl hydrazine (DNPH) method [slides 16-21].

The semi-continuous formaldehyde monitor was developed with EPA support by Texas Tech University for application to air toxics monitoring and photochemical modeling. The monitor can measure formaldehyde concentrations from 0.1 to 50 ppb, runs one complete cycle in ten minutes, and can operate for seven days without need for consumables, among other features

[slides 25, 26]. It is less labor-intensive and less expensive than the current methods, and allows collection of more data points for modeling purposes. It can only monitor for one compound, however, and its size and power requirements limit its applicability to ambient site or stationary monitoring [slide 29-30].

Improvement of the monitoring capabilities for 1,1,-DCE and other VOCs is also underway to help with ORD's Regional Monitoring Initiative (RMI). Under the RMI program, EPA Region 8 requested support to develop a method that would attain lower detection limits for 1,1,-DCE and other VOCs, and to review canister-based sampling and analysis methods for these compounds (listed on slide 34). Preliminary results showed that the methods can now detect concentrations in parts per trillion, compared with the previous method's parts per billion. The cleanliness of canisters and adequate standards were also found to be important factors in the accuracy of results.

ORD's work is addressing known problems with methods, in order to increase the accuracy of monitored results. Methods also need to be less expensive and less labor-intensive. In addition, methods applicable to ambient, personal, and residential monitoring can facilitate comparisons.

Questions and Comments

Question: Are there any plans to increase ORD's focus on method development?
Response: We plan research a few years in advance through our planning process. We would like to develop a methods program, but it is difficult to change research directions quickly. Although we (ORD) are aware of the need for methods.

Question: Can these methods be calibrated depending on the environment where the monitoring would take place (e.g., indoor vs. outdoor)?
Response: I cannot answer this specifically. Don Whitaker and Bill McClenny can answer specific questions about these methods.

Question: For the DCE method, who decided how low the limit of detection should be? It is important for a monitoring person designing a study to know that.
Response: The Office of Air Quality Planning and Standards (OAQPS) has developed a hierarchy of data sources for toxicological data, including the detection limits that methods should meet (or measure below).

Comment: Regarding the existing carbonyl method (DNPH), the regions have some suggestions for ORD, if there are plans to update these documents.
Response: Historically we do ask the regions for comments. However, we have lost the funding and full-time equivalents (FTEs) related to that, so there are no plans right now to update it.

Atmospheric Formation and Decay of Air Toxics – Implications for Exposure Assessments – Deborah Luecken (ORD/NERL)

Chemical processes can lead to the formation of compounds in the atmosphere, or their decay through chemical reactions. Since this can affect the concentrations of air toxics, atmospheric chemistry may have important implications for both modeling studies and monitoring network design.

Pollutant decay can be quantified by using a chemical's half life or lifetime [slide 3]. Decay processes can result from reactions with the hydroxide (OH) radical, ozone (O_3), or the nitrate (NO_3) radical. Reactions with OH can affect almost every pollutant, and this is usually the most important reaction during daytime hours. Reaction rates are dependent on both temperature and OH concentration, so routine measurements of OH are necessary for this process to be taken into account. Reactions with ozone are less important than those with OH, and usually only affect those compounds with double bonds. Ozone concentrations can vary both throughout the day and seasonally, being higher in summer than in winter. Reactions with the NO_3 radical are important only at night, and only for a few species. Other decay processes that occur in the atmosphere include photolysis in sunlight – which can be important for some compounds during the day, but highly variable; and processes involving other reactants in the gaseous or liquid phase. Slide 9 lists some of the common air pollutants and the atmospheric processes important in their decay.

Atmospheric processes can also lead to the production of air toxics, some of which can be produced by other air toxics or VOCs. Atmospheric formation can transform one state of a toxic to another and is usually only important for certain species. However, it can be a major source of formaldehyde, acetaldehyde, and acrolein. Both formaldehyde and acetaldehyde can be formed from any VOC in the atmosphere, and it is estimated that 85-99% of these aldehydes are due to atmospheric formation, rather than emissions [slides 11, 12]. Acrolein can be formed from the decay of 1,3-dienes through cleavage of the double bond [slide 14]. Other air toxics, potential air toxics, and some metals can also be formed from atmospheric reactions; thirty of the 188 air toxics listed in the Clean Air Act can be formed in the atmosphere from secondary sources.

Since atmospheric chemistry can be highly variable, it should be taken into account in monitoring studies. Monitors could be placed downwind of large sources, and should measure the major aldehyde precursors, even if they are not themselves air toxics. Atmospheric chemistry should also be considered in modeling, as it can significantly affect the predicted concentrations of some chemicals. However, these reactions are not adequately verified for all pollutants. Atmospheric reactions can also form compounds that may be harmful or important in

processes such as deposition to water or soil; reactive species which can increase ozone formation; semi-volatile species, or greenhouse gases. Controls in one type of air toxic should impact other pollutants as well. Further research is needed to improve understanding of air toxics chemistry, including the chemistry of transition metals and their products. Better evaluation of model predictions for formaldehyde and acetaldehyde is also needed, as is an improved understanding of the toxicity of photochemically-produced compounds. Atmospheric chemistry would be especially useful to include into air quality models, over long periods of time and large domains.

Questions and Comments

Question: What are the differences and similarities in indoor and outdoor environments?
Response: No photochemical processes can occur indoors, since they require dissolution reactions and the formation of radicals. It may be possible for ozone reactions to occur indoors, however.

Comment: A method has been developed for quantifying the amount of formaldehyde converted to acetaldehyde.

Comment: Defining the concentration of the hydroxide radical is really difficult, because we have no good measurements. Models could be used to estimate these concentrations.

Question: There are ways to simplify the mechanisms of these reactions. How detailed does the chemistry need to be for the purposes of modeling?
Response: You should measure everything, if possible, since every simplification will add a measure of uncertainty. This also depends on the compounds and reactions, and how much uncertainty you can accept.

Question: I have never seen precursor data used for anything. How should we use such data?
Response: It can be useful for evaluation of models for ozone, as well as for PM and some other compounds.
Comment: The expense involved in this can be a problem.
Response: However, if such data has been collected, it should be used.

Question: Some states have mentioned that they collect a lot of data that is never used or looked at. Why is this data not used?
Response: Sometimes it is collected as part of a regulatory requirement – for the Superfund program, for example. It would take a lot of work and a lot of people to be able to do something with that data.

Air Toxics Monitoring Methods and Network Design – Steve Bortnick and Shannon Stetzer (Battelle Memorial Institute)

Data from the Urban Air Toxics Monitoring Program (UATMP) for VOCs and carbonyls spanning the years 1996-1999 were analyzed to identify and quantify sources of variability. Duplicate and replicate samples were used including multiple sites, multiple days within sites, duplicate samples on each day at the same site, and replicate analyses of each collected sample. Sources of variability included spatial, temporal, sampling, and analytical variability. Graphs were presented showing the data in relation to combinations of these sources [slides 5-10]. Temporal variability was the driver for most data variation, and in many cases environmental variability (i.e., ambient or natural variation) was more significant than monitoring uncertainty (i.e., measurement of man-made variation). At low ambient levels, however, environmental components of variability tended to decrease, and monitoring uncertainty, particularly analytical relative error, would take over.

Data were plotted to show variation as it related to annual concentration means for benzene, acetaldehyde, and manganese [slides 14-16] and equations presented to demonstrate how the relationship between variance and concentration can be used to estimate optimal sampling frequency [slide 13]. Annual concentrations were also plotted against the annual average errors [slides 18-23] and used to devise a formula for calculating precision as a function of sampling frequency and mean ambient level.

Bias, or systematic differences, related to the monitoring technologies used was also analyzed, and twenty-four-hour canister benzene monitors were found to record consistently higher concentrations than PAMS monitors.

Spatial and inter-compound correlations were also examined. Using data from the MATES II study, measurements were matched for the same compound and on the same days at different sites, for a total of forty-five site-to-site combinations per compound. Correlation coefficients were calculated for each compound, as was the distance between sites. Correlations were presented against the distance between sites from north to south and from west to east [slides 32-35]. Compound to compound correlations were calculated for twenty-one compound pairings per site, including carbonyls vs. other classes, metals vs. other classes, and VOCs vs. other classes [slides 38-40]. A positive correlation was found between formaldehyde and acetaldehyde concentrations; such comparisons may be performed with classes of chemicals in the future, rather than using all 188 pollutants.

Four spatial case studies were presented. In Portland, Oregon, a study was designed to demonstrate the effect of local point source emissions across a wide range of air toxics:

carbonyls, metals, and VOCs [slides 42-44]. Five sites were set up to take twenty-four-hour samples every sixth day for one year. High spatial variability – well over 100 percent relative error– was observed in compounds that had significant local sources. Variability decreased once one such site was dropped. Nickel, manganese, and iron exhibited both high overall and high spatial variability. In Iron County, Missouri, a study demonstrated the effects of controls (source reductions) on monitoring needs [slide 45-47]. Four monitoring sites were present from 1993 through 1999, all surrounding a lead smelter. Very different values were obtained from the four monitors from 1993 to 1996. After the implementation of controls in 1996, however, variability dropped to the extent that it would be possible to only maintain one monitor instead of four. The Shelby County, Tennessee case study [slides 48-50] demonstrated the impact of a local point source on spatial variability and the geographic extent of the impact. The data analyzed were from five sites, two of which were located with a half mile of a battery recycling plant. These two sites were the major contributing sources of variability in measurements, and variability dropped dramatically when the two sites were not included in the analyses. In addition, it was determined that the impact of the plant's emissions became negligible at distances greater than seven miles. The fourth case study, in Cook County, Illinois [slides 51-53], considered the impact of local point sources and corresponding monitoring objectives on spatial variability. Data were analyzed from seven sites, two of which were reported to be point source sites, located near steel mills. As in the Tennessee study, variability among locations was reduced when the two point source sites were excluded from the analysis. In addition, similar variability was exhibited by other closely clustered sites.

The last set of data analyzed was obtained from the Air Toxics Pilot Study. Battelle Memorial Institute is currently acquiring all data collected at each of the ten pilot cities including ambient measurements, meteorology, and other ambient data. Following QA/QC the data will be converted to appropriate data sets for analysis. The database should be complete in 2002 and may be made available to the public by late 2003. Some issues with the data that have been observed so far include numerous formats and reporting units, and numerous different conventions of reporting data below the minimum detectable limits (MDL). Data analyses will include inter-laboratory variability analysis, monitoring data variability analysis, and MDL and reporting analysis. A draft report is planned for early 2003; the results will also be presented at the National Air Toxics Workshop in spring 2003. To obtain more detailed information related to the data analysis results presented and summarized above, e-mail Mr. Michael Koerber of the Lake Michigan Air Directors Consortium for a copy of the draft report (ladco@ladco.org).

Questions and Comments

Question: What are the conventional units?
Response: Most data is either collected in or converted to micrograms per cubic meter (: g/m^3).

Comment: In the latest study we were asked to report in those units to reflect local conditions.

Comment: The transformation of data can introduce a new component of uncertainty – we need to be consistent across all data of interest.

Question: Didn't Battelle receive a contract to do that?
Response: We are trying to put together a database with high QA/QC and make it available publicly, possibly on a website through the Aerometric Information Retrieval System (AIRS) database.

Question: Are there atmospheric chemistry reasons why you would expect correlations between formaldehyde and acetaldehyde?
Response: Yes, they come from the same sources.
Question: Does that eliminate the need for a separate aldehyde or acrolein method?
Response: I would not say that it eliminates that need; measuring both would provide a good check on the data.
Comment: Similar correlations are seen with butadiene and benzene – they have the same source. Research is being conducted to look at such correlations in a number of chemicals.
Comment: We do not know that there is a good correlation between acetaldehyde and acrolein; their sources are not the same, as with formaldehyde.
Comment: The contribution of various sources is an important issue in air toxics. Scattered point sources may give localized high concentrations, but that is not necessarily a correlation. The same issue exists with indoor versus outdoor measurements. It is important to understand the distribution of exposure that results from the nature of the source.

Question: What is your opinion of the PAMS program?
Response: It is appropriate for what it was intended to do.

Comment: Toxic endpoints of air toxics are moving towards non-cancer, short-term exposure endpoints. We may be more interested in distributions than in annual averages. These exposures may not be linear with respect to time.
Response: It is possible to get that information from the data; analysis will depend on the objective of the study.

Comment: A method has been developed that can be used for source apportionment.

Comment: A source-receptor model is needed so that we can link sources to health effects.

California Monitoring Program: Statewide Network to the Neighborhood Scale – Jeff Cook and Linda Murchison (California Air Resources Board)

Jeff Cook reported the preliminary results of a study intended to further the understanding of network scale, size, and effectiveness. The monitoring program in California was established when laws passed in the 1980s required the Air Resources Board (ARB) to identify and regulate air toxic emissions. Monitoring began in 1985 and was eventually used to develop control measures for air toxics. Progress since the beginning of the program has included the development of new and modified methods, improvements in the limits of detection, and a change in sampling media. NIST standards are used as the primary standards for calibration; an aggressive QA program includes a manual and quality control reports, inter-laboratory comparisons in lieu of round-robin testing, and collocated sampler sites for precision purposes. The number of air toxics contaminants reported has increased five-fold since 1985 [slide 7; list of compounds on slide 8], and the current database contains approximately 50,000 determinations. Data are publicly available as annual summaries on the ARB website [slide 12], including minimum, maximum, and mean concentrations, detection limits, number of observations, and estimated cancer risk. The summaries show almost a seventy-five percent drop in risk between 1990 and 2000.

Inter-site variation analyses considered benzene (a motor vehicle pollutant indicator), perchloroethylene (a point source indicator), carbon tetrachloride (indicator of a globally pervasive pollutant), and hexavalent chromium (a point source indicator not usually found in ambient samples). These are four of the eight compounds which make up ninety-nine percent of the ambient risk. Monitoring networks exist at the statewide, regional, and neighborhood scale [slides 17-19]. Both variability and trends were examined by simple comparisons at the statewide and regional levels.

Benzene means from statewide sites generally fell within a factor of two; a factor of four separated the lowest from the highest concentrations. Peaks were evident in heavily industrial locations, and near the Mexico border [slide 22]. Means were also comparable among the regional sites [slide 22]. Plots of moving average concentrations over time were presented for several areas and were comparable to the national average with the exception of the South Coast Air Basin, where values were notably higher than the national average [slides 24-28]. The seasonal profile was consistent in four locations [slide 29], likely due to motor vehicle pollutant contributions.

Perchloroethylene exhibited less variation among sites than might be expected, considering it is a point source pollutant. This could be due to a well-mixed background from a multitude of sources, or indicate that some sources are not detected by the national network. Only one

location (Burbank) exhibited a significantly higher mean [slide 31]. More detail is revealed when shifting to a smaller scale and denser network, with levels varying from very low to very high [slide 32]. Two-year moving averages were overall consistent with the national average [slides 33-36] with higher values evident in the South Coast area [slide 37]. In plots of seasonal variability [slides 38, 39], the concentration peaks were not uniform among locations, as was the case with benzene concentrations. Data also revealed exceptionally high values in the San Rafael area, due to a dry-cleaning facility [slide 40]. This site illustrates the need for neighborhood monitoring in some cases.

Carbon tetrachloride concentration means were very similar among both the statewide and the regional locations – results that were expected since most ambient carbon tetrachloride comes from background concentrations [slides 43, 44]. Two-year moving average concentrations were very similar to the national average [slides 45-49], and carbon tetrachloride exhibited virtually no seasonal profile [slide 50].

Hexavalent chromium, another point source pollutant, exhibited less variability in the statewide locations than would be expected [slide 52], with values in some locations averaging below the limit of detection. Burbank was an exception, with high values for all three years plotted. Two-year moving average concentrations were consistent with the national average in all locations except the South Coast area, which had high values overall, with the highest values in Burbank [slides 53-57]. Slides 58 and 59 illustrate the same results in two different scales. These show low concentrations in El Cajon and Chula Vista, two areas near San Diego. Neighborhood site values from the same area, however, show very high results for some areas, in particular a site located on Newton Street [slides 60, 61]. The neighborhood results were obtained through small-scale monitoring during the Barrio Logan case study.

Linda Murchison presented the outcome of a study that began when the Air Resources Board was invited to monitor in the Barrio Logan community in San Diego in 1999. Monitors were located at Logan Memorial Academy [slide 2] and measured all criteria pollutants for seventeen months. The monitoring results were very similar to results from the San Diego region as well as the statewide average. Most hexavalent chromium values were below the limit of detection [slide 5]. In December 2001 additional monitoring was performed at six sites near two chrome plating facilities in an attempt to understand neighborhood exposure. Two weeks of monitoring revealed very high levels of hexavalent chromium; the source of these emissions was unclear, however, due to the presence of multiple small sources in the area. Further monitoring was conducted to determine the source of the problem and to understand neighborhood exposure. The second round of monitoring included the six original sites; additional monitoring of twelve-hour chromium and twenty-four-hour metals at 2121 Newton Street; and indoor monitoring at both chrome plating facilities located nearby. It was noted that both plating facilities had been in compliance with regulations at the time. The first two weeks of data did not show the very high values measured in December, but some peaks were still evident, as was a relationship between

the Master Plating facility and 2121 Newton Street [slides 22-24]. Modeling analysis assuming Master Plating to be the chrome source matched the observed data [slide 25, 26] and confirmed this as a localized source, as concentrations dropped off a short distance from the facility. The modeling results also helped refine the next stage of monitoring, which was continued only at 2121 Newton Street and an alley adjacent to Master Plating. In addition, weekend monitoring was conducted, and a restraining order to stop chrome plating at Master Plating became effective on March 25. Results obtained from March 11 through March 24 confirmed the relationship between Master Plating and 2121 Newton, and revealed a strong correlation when winds were from the west. Indoors monitoring revealed that hexavalent chrome made up 90% of total chrome in the plating facility, and 55-60% of the total in 2121 Newton Street. As expected, concentrations dropped to close to ambient values when plating was not taking place, after March 25. Some high values measured after that date were attributed to chrome dust disturbed by cleaning activities at Master Plating; and a very high value [slide 33 - April 5-6] was the result of construction of a secondary containment tank, mandated by the restraining order. To complete the study, a last round of monitoring at sites based on model predictions confirmed that the second plating facility in the area was not a contributor to the high chromium emissions.

Study results validated the use of both exposure and diagnostic sampling. Frequent sampling may be necessary in similar situations, and monitoring networks can evolve as new information is revealed. Statewide implications derived from the study include the issue of fugitive dust as a contributor to hexavalent chromium – as evidenced by increased values on days when cleaning and construction were taking place at Master Plating. The state may also need to examine whether a fume suppressant is adequate to reduce emissions from chrome plating facilities. It was noted that such studies can get costly – the total cost of the Barrio Logan case study was approximately $1 million.

Jeff Cook completed the presentation by summarizing the lessons learned and the issues raised by the study.

Regional Monitoring:

- Can be a reasonable and cost effective means of assessing exposure to motor vehicle and similarly prevalent pollutants;
- Has supported identification and adoption of control measures of motor vehicles, fuels, point, and area sources;
- Has adequately addressed changes in air quality levels due to fuel switching and other motor vehicle controls;
- Can detect well-mixed cumulative emissions from many small sources;
- Can capture one aspect of point source monitoring, yet may overlook sub-regional exposures to high risk pollutants and the need for additional source controls;

- A dense regional air monitoring network can provide useful information on exposure due to neighborhood point sources.

Regional vs. neighborhood monitoring:

- There will be trade-offs between regional and neighborhood monitoring resources. Sampling frequency, number of sites, and duration, need to be carefully balanced to achieve the objectives of both.

Neighborhood monitoring:

- Provides a distinct view of disproportionate risk that often exceeds that expressed by regional monitors;
- Is particularly effective when sources are clustered and pollutants are high risk compounds;
- Can be dynamic; interest is often greater, and objectives are likely to evolve;
- Point source monitoring will be comprehensive and time consuming;
- Should have a point of instigation, such as a community concern. A source category or cumulative impact of sources must be identified.

Modeling:

- Near-source modeling has a role in assisting neighborhood monitoring design;
- Neighborhood modeling places greater demand on the need for local, facility-by-facility emissions information.

To help justify the cost incumbent in neighborhood monitoring studies, local findings need to be leveraged to a larger result. These findings are transferable and can benefit other communities with similar problems, as evidenced by the Barrio Logan example. The Barrio Logan study impacted statewide chrome measures. Although not the only driving force, neighborhood monitoring can be the basis for strengthening emissions controls from point sources.

Questions and Comments

Comment: Even though both plating facilities were in compliance with regulations, the inside concentrations were very high. This may indicate a need for cross-training for inspectors. Also, the values may have been high enough to contact the Occupational Safety and Health Administration (OSHA).

Response: The values were not high enough to contact the California OSHA, but they are investigating both facilities.

Question: How did you keep the community updated?
Response: We met with the community every couple of weeks. The city has attempted to relocate Master Plating, and their current goal is to separate the residents from such facilities.

Question: Did you take blood samples?
Response: We did not. The community has requested blood sampling for lead, however, and it may be provided through the Health Department.

Question: What particle size dust were you concerned about?
Response: The measurements taken were for total suspended particles. We have not looked closely at this data yet for particle size.

Question: It seems that such a close look may be required at other places as well; any thoughts on whether there may be a way to divide the high cost of these studies nationally?
Response: A big question every time we undertake community monitoring is whether we are prepared for the results. Rather than doing industry-by-industry case studies, a better approach may be to develop modeling or state/regional-level monitoring tools that will better capture results at the community level. The idea of sharing the cost and information is valid, however.

Comment: EPA has developed a simple computer-based model that anyone can use, and that is just the type of tool that was just mentioned. This tool is the Metal Finishing Facility Risk Screening Tool (MFFRST). It can be accessed at:

http://www.epa.gov/ncea/mffrst.htm

The EPA contact is Matt Lorber in NCEA. He can be reached at (202) 564-3243.

Design Your Own Air Toxics Monitoring Network – Motria Poshyvanyk (Region 5)

Motria Poshyvanyk gave a presentation which described the exercise and provided guidelines and suggestions. One adjustment was made to the directions: to allow for multiple short-term monitoring sites in the small-scale network, it was assumed that there is no cost to the establishment of a monitoring site. Other directions applied.

All participants were divided into four groups - two groups for each type of monitoring network, large-scale and small-scale. Each group was selected to include two or more people with significant monitoring experience. Other specialists (meteorologists, toxicologists, etc.) were randomly divided. The groups worked separately, and were all provided with a poster-sized map to write on. Each group was assigned a facilitator to lead the development of the network. A volunteer was identified to present the designed monitoring network to the reconvened participants.

Network #1: Large-Scale Urban Area

Blue Group: Facilitator Barbara Morin

Yellow Group: Facilitators Tim Watkins, Deborah Luecken

Network #2: Small-Scale Local Hotspot

Green Group: Facilitator Neil Frank

Red Group: Facilitator Motria Poshyvanyk

Blue Group

The group identified pollutants of concern as VOCs (benzene, 1,3-butadiene), carbonyls (formaldehyde, acrolein), and metals (chromium). The group added toxics monitoring to existing $PM_{2.5}$ sites where possible. The two existing $PM_{2.5}$ speciation sites were supplemented with hexavalent chromium, VOC, and carbonyl monitors and one-in-twelve-day duplicate sampling ($173.5K). VOC and carbonyl monitors were added to ten existing $PM_{2.5}$ mass sites in four demographic areas on a one-in-twelve-day schedule ($300K). Metals analysis was added to three sites ($24K) and limited acrolein monitoring was performed to test the new technology ($7K).

Yellow Group

The group upgraded some PAMS sites to year-round VOC monitoring: an upwind background site and a site downwind of airports to the north of the city. VOC monitoring was also proposed for $PM_{2.5}$ speciation sites and a $PM_{2.5}$ mass monitor in an environmental justice area. Proposed metals sites included: one metals site near Gary, Indiana; metals and hexavalent chromium near O'Hare airport; metals and hexavalent chromium at a population oriented urban site. Carbonyls and acrolein were added to all VOC sites. Finally, two background sites were set up at $PM_{2.5}$ locations in the distant suburbs.

Green Group

The group gathered additional information: 1) updated source inventory, 2) collected on-site meteorological data, and 3) conducted a local modeling study ($10K). Potential monitor sites included schools, playgrounds, parks, as well as areas of predicted high concentrations. Hot spots were identified via saturation monitoring for several days (twelve-hour sampling) and by dispersion modeling results. Saturation monitoring consisted of twelve sites operating for three months on a one-in-six-day schedule; an alternative plan was twelve sites for two weeks daily.

Red Group

The group organized a meeting ($5K) with local groups to confirm the locations of perchloroethylene operating dry cleaners and to ask residents about perceived hot spots resulting from S&C emissions and local dry cleaners. Phase I included meteorological measurements to determine prevailing wind patterns ($20K); a screening dispersion model ($10K) was used to identify the area of S&C maximum impact. Several short-term sites were set up in a grid pattern in the northeast quadrant to identify high perchloroethylene areas ($90K). Phase II included the establishment of three long-term monitoring sites ($31.5K each): one site in a high perchloroethylene area in the northeast quadrant; one site at the site of maximum S&C impact; and one site representing a typical mix of perchloroethylene, S&C, and mobile source emissions in the community. Phase I was estimated at $125K and Phase II at $94.5K.

SESSION III: MODELING TOOLS – CURRENT AND FUTURE

Co-chairs: Randall Robinson (Region 5), Joe Touma (OAR/OAQPS), and Tim Watkins (ORD/NERL)

Randall Robinson (Region 5) began session three and outlined the topics to be covered: general information on air quality models; an overview of how these models have been used in the past; and future directions in air quality modeling.

Air Quality Models – Joe Touma (OAR/OAQPS)

Models have been used for air quality management since the early 1960s by Agency programs and regions. Their main role has been in facility permitting. Other uses, including demonstrating the adequacy of emission limits and policy analysis, utilize the capacity of models to project conditions into future years. As discussed in earlier presentations, modeling results can also assist in the selection of monitoring sites. Combined with emissions inventory data and air quality monitoring, modeling can be used as part of risk assessments leading to development and implementation of regulations [slide 4].

All air quality modeling systems include two major components: an emissions model and a meteorology model. The accuracy of any model output is dependent on the quality of the data put into it. Meteorological and topographic complexity and user expertise also play roles. Overall, models are most accurate in simulating long-term averages in simple topography. Numerous types of air quality models are currently in use by EPA, ranging from screening to refined. Screening models are generally applied prior to refined models; they use one or a few groups of sources and conservative estimates of concentrations. Refined models include Gaussian plume models and numerical grid models. Gaussian plume models use meteorology information obtained at the source and assume it holds true throughout a fifty-kilometer perimeter. Wind direction is used to predict concentrations following the plume of emissions from a source. This type of model is most widely used for non-reactive pollutants. For reactive pollutants, or where there is complex topography, numerical grid models are used. These require complex wind flow and other meteorological information, and consider the chemical transformation of compounds in the atmosphere (e.g., ozone).

Models (both screening and refined) are developed by EPA, other government agencies, and private sources. EPA models in particular undergo extensive evaluation and statistical measures of performance. The executable and source codes of models developed by government agencies are publicly available for use by anyone. Some private industry models are also available to use at little or no charge, as listed in the *Guidelines on Air Quality Models*. Supporting tools and

sources of data for input into models are also available, including meteorology and terrain data, emissions data, and census data.

EPA's National Scale Air Toxics Assessment (NATA) provides an example of model use in policy analysis. The NATA study used Gaussian models to predict lifetime estimates of exposure and risk for urban air toxics. The model is run every three years when NATA is updated and results are used to prioritize data and research needs and to provide a baseline for measuring future trends. Ambient concentration and emission results from the 1996 NATA were presented [slides 15, 16].

Resources and information on air quality modeling are provided through the Support Center for Regulatory Air Models (SCRAM) website, as well as by the Air Pollution Training Institute (APTI). The website contains the code, user's guides and other guidance documents for many air quality models, proceedings from the 7th Modeling Conference, a forum with frequently asked questions, and links to other websites. The APTI provides classroom, on-line, and self-instructional courses, satellite courses, workshops, and seminars. Website addresses are:

SCRAM website:
http://www.epa.gov/ttn/scram

Air Pollution Training Institute course listings:
http://www.epa.gov/oar/oaqps/eog

The EPA has been a leader in air quality modeling for air toxics assessments, and improvements continue to be made in providing different models for different situations. A future direction the Agency might consider is whether we should become involved in the area of homeland defense. Concern regarding the intentional release of harmful chemicals existed prior to the events of September 11th, and the Agency does not currently have models to deal with such a situation where concentrations are paired in time and space. A decision will need to be made on whether this should be a matter for EPA to undertake, or whether the Agency should stay within its current focus of general population exposure to air toxics.

Using Emission Inventories for Air Quality Modeling – Joe Touma (OAR/OAQPS) and Madeleine Strum (OAR/OAQPS)

The emissions inventory is a fundamental building block in developing an air quality control and maintenance strategy. Inventories are useful in identifying sources and general emissions levels and in providing input to air quality models. They can also provide information on trends over time that can be used in EPA reports to demonstrate that goals are being met. In order for inventory data to be useful as model input, inventory preparers and air quality modelers must work together to understand the needs of air quality models and limitations of the inventory. Emissions models and processors commonly used include Sparse Matrix Operator Kernel Emissions (SMOKE), Emissions Modeling System (EMS95/2000 and 2002), and Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) – the latter being the model used in the NATA study.

EMS-HAP is an emissions processor used in combination with inventory data and the Assessment System for Population Exposure Nationwide (ASPEN) dispersion model and the Hazardous Air Pollutant Exposure Model (HAPEM). Emissions inventory locations are converted using EMS-HAP to air dispersion model coordinate units. Quality assurance is performed on stack parameters, and default values are available to use if necessary. These are then used to group and speciate pollutants and spatially allocate non-point source emissions. Since inventory data is annual, emissions can then be temporally allocated, assigned source groupings, and formatted in a model-ready format for the ASPEN dispersion model [slides 6-8]. For national-scale modeling, EMS-HAP can assign source locations and stack parameters when needed, based on information on the percentage of states that did not provide emissions data. Partitioning information for metals is another feature of EMS-HAP, giving a user the option of specifying which species of a metal should be used in the analysis. An approach also exists for speciating chromium compound emissions into hexavalent chromium [slides 9,10]. Speciation data from various sources is now being collected in order to augment this aspect of the model. Spatial allocation of non-point source emissions is accomplished by using census tract population data or a similar surrogate to allocate emissions at the county level; consumer products are an example of the types of emissions that can be estimated using this approach. Temporal allocations take into account inventory data, day-of-the-week and seasonal variations, and temporal profiles. Other functions performed by emissions processors such as EMS-HAP include assigning source groups to ambient emissions, projecting future emissions scenarios, and producing model-ready input files.

Emission processors automate the process of preparing the inventories needed to manage an air program, and ensure that inventories have the appropriate level of detail to support modeling.

Model Applications: Local and Urban Scale Modeling

Local Scale – Barrio Logan Modeling Analysis – Vlad Isakov (California Air Resources Board)

A conceptual modeling protocol was developed for the Barrio Logan neighborhood near San Diego, California. Local emissions and local scale modeling results were used to calculate the inhalation risk at Barrio Logan. The study also served to evaluate the model used. Ultimately this effort will develop and evaluate methodologies to estimate annual average concentrations of various pollutants released from multiple sources at the neighborhood scale. The modeling working group included participants from government agencies, universities, industry, and environmental groups. Modeling was conducted at the neighborhood scale with receptors located near emissions sources, and at the regional scale – up to the size of air basins – to adjust for regional background. Thirty pollutants were modeled at the regional scale and more than one hundred at the neighborhood scale [slide 5]. Both traditional and advanced models were used to estimate annual concentrations [slides 6, 7] and to identify those that are best suited for assessing neighborhood impacts. The study is also expected to develop recommendations and guidelines for assessing the cumulative impacts posed by air pollutants at the neighborhood scale. Modeling results and recommendations will be shared with EPA and other interested groups.

Maps of Barrio Logan and the surrounding area were presented that indicated daytime and night-time wind directions and the locations of emissions sources – including point sources, road links, rail lines, and shipping lanes [slides 10-13]. Inhalation risk based on predicted concentrations of local emissions was estimated for benzene, hexavalent chromium, diesel PM, and all pollutants combined [slides 14-18]. Benzene risk became more significant near highways, and hexavalent chromium risk was high in two hot spot areas. Combining risk from all sources except diesel PM showed the hot spot point sources to be the most significant contributors. When all sources were combined, diesel PM emerged as the largest factor contributing to total risk; shipping lane emissions contributed more to total diesel PM than highways or rail lines.

Further analysis included simulations with the AERMOD and CALPUFF models, adjustment of background concentrations using results from regional modeling, and tracer studies to evaluate model performance. Regional modeling using the Community Multi-Scale Air Quality (CMAQ) model revealed a hot spot with high concentrations of formaldehyde [slide 20] that correlated with the results of other models as well as the monitoring annual average. The tracer study used both samplers and a mobile monitoring station to take measurements from fifty sites in August and December 2001. The tracer was released at a central location, and samples were taken to compare model predictions of concentrations at various distances and directions radiating from

the release site. Measured tracer concentrations showed good agreement with those predicted by the model [slide 27]. Future model evaluation will include a second tracer study, comparison of modeling results using a new database, and the publication of guidelines identifying the models and model options best suited for assessing neighborhood impacts.

Uncertainty analysis was also performed to identify major sources of uncertainty, and to develop a methodology for assessing uncertainty in annual average concentration estimates. Models were broken down into their components and available data were used to represent model inputs as distributions. A dispersion model was applied and statistical sampling used to estimate the range of possible model results [slides 30-32]. A Monte Carlo simulation calculated the uncertainty – percent difference – and confidence intervals for each source of uncertainty [slides 33-35]. Emissions were the dominant source of uncertainty in this case, although the model was sensitive to all factors. The magnitude of uncertainty was greater near the sources and decreased with distance. The development of modeling guidance was deemed important for the AERMOD model, which is more complex than ISCST3 and capable of providing a wider range of results.

Urban Scale Modeling – Houston Case Study – Joe Touma (OAR/OAQPS)

The National Scale Air Toxics Assessment (NATA) conducted by EPA modeled ambient concentrations, exposure, and risk for thirty three air toxic pollutants. The modeling domain included the continental United States at the census tract level and showed the contributions of major area and other sources as well as background. NATA results are available at:

http://www.epa.gov/ttn/atw/nata

At the regional scale, refined dispersion model analysis can improve upon the NATA assessment for urban areas. Improved modeling tools can provide a better description of air quality as well as a higher degree of resolution than the national scale study. Such comparisons should also help identify data gaps in the national scale study. Conducting urban-scale assessments for a number of cities is one of the components of the Integrated Urban Strategy (64FR137, July 1999). Data from the emissions inventory on point/non-point sources and road/non-road mobile sources were refined for the purposes of the urban study. Specific locations were determined for point sources, and non-point sources allocated from county-level to one kilometer grids; on-road mobile sources were allocated using local traffic counts, road locations and emission factors; and non-road mobile sources were allocated from the county level to one kilometer grids. The ISCST3 model, used for the urban study, provided better area source representation than the ASPEN model, included deposition, and added simple chemical transformation processes. This more detailed analysis provided more realistic patterns and better agreement with monitoring data than the national scale study. In addition, hot spots were found by the urban scale study that did not appear in the national scale study. Assessment at this scale, however, still cannot be used for neighborhood-scale concentrations.

The use of the ISCST3 model in this urban scale study demonstrated that results are improved when emissions can be placed in more precise terms. Allocating mobile emissions to actual roadways is preferable to allocating county mobile emissions using surrogates. This improved agreement was confirmed by comparing modeled concentrations from the national scale and urban scale studies with monitoring data from seven sites in Houston. Accurate emissions allocations, and the consideration of factors such as deposition, become even more important when models are intended for use in estimating exposure to and risk from air toxics.

Questions and Comments

Comment: Air quality modeling is inseparable from inventory data if we want to assess short-term exposure. Data used for transportation planning is available from numerous sources and can also be used for inventory purposes.

Comment: Models are not as easily understood by the community as monitoring data, and this is one of the reasons why we often opt to use monitoring. We need a better sense of the meaning of results from modeling studies as well as monitoring programs.
Comment: This is one of the big challenges in air toxics, since we have 188 chemicals' names in the CAA. We have a good understanding of some, but know little about others.

Question: Is penetration of chemicals from outdoors to indoors taken into account with this model?
Response: There are other models that can be used for indoor penetration and concentrations.

Comment: Improving the quality of the data used for emissions inventories is important, since data are frequently used as input for modeling.
Comment: The CAA requires that criteria be set for emissions, but no such requirements exist for air toxics. For example, inventory data from many states improved considerably after the states started reviewing the national scale assessment results.
Comment: The NATA study has shown no air toxics "problems" outside of urban areas; however, it is a national average, and may not reflect local conditions.

Comment: Judging from this study, it would seem that modeling could cost more than a monitoring study.
Response: It can be more expensive in some cases. Deciding between monitoring and modeling should depend on the purpose of conducting a study. Monitoring can take more time, and offers no projections for hypothetical situations or future years. If goals will be satisfied by monitoring, then it should by all means be done, especially if it is also more cost-effective.

Applying CMAQ Models3 for Air Toxics Assessments – Bill Hutzell (ORD/NERL)

The concentrations of many air toxics depend on meteorological, physical, or chemical processes that cannot be treated simultaneously by standard regulatory models. The Community Multiscale Air Quality (CMAQ) model system was used to determine if it could be adapted to assess the fate of such compounds.

CMAQ is a Eulerian-based system, or a grid model, that simulates urban and regional scale transport and chemical processes. A fusion of three models [slide 5], CMAQ uses the "one atmosphere" approach for air quality and deposition modeling. Current research includes continental and regional studies including atmospheric fate modeling of emissions, air concentrations, and deposition for mercury, dioxins, and select hydrocarbons.

CMAQ is being adapted to simulate the deposition of mercury, taking into account its gas and aerosol species, cloud chemistry, and gas chemistry, and using the Regional Acid Deposition Mechanism (RADM). CMAQ mercury deposition simulations were performed for the spring and summer of 1995 and results were compared to observations from the Mercury Deposition Network [slides 9, 10]. Spring results had better agreement with monitoring data than those for summer, likely because summer rainfall was predicted poorly by the model. Simulated cloud chemistry agreed with most other models and cloud water model predicted concentrations were within the range of observed concentrations; however, questions and uncertainties remain about both these processes. Model behavior for wet deposition showed moderate accuracy in cool seasons, but poor accuracy when convective precipitation was prevalent. More comprehensive testing is needed to resolved these issues and improve model predictions.

Several toxic compounds are implicitly simulated in existing chemical mechanisms within CMAQ [slide 13]. Volatile organic carbons labeled as air toxic will be added to CMAQ and the chemistry mechanism for ozone will be simplified in order for the model to support the 1999 National Air Toxics Assessment (NATA). Formaldehyde and acetaldehyde were simulated by running CMAQ using the SAPRC99 mechanism [slides 14, 15]. In the future, the CB-IV mechanism will be used for these compounds, since it produces similar results but runs faster than SAPRC99.

CMAQ can also be used to simulate the atmospheric fate of dioxins and furans [slide 16]. Expanding chemical and aerosol species, including loss and degradation processes, simulating gas to aerosol exchanges, and obtaining reliable emissions data are among the challenges faced in updating CMAQ to include dioxins. A test scenario run for a two-week period in April 1995 showed predicted deposition and predicted average air concentrations compared to emissions

[slide 18]. Congeners can be treated individually and an estimates of their contribution can be obtained [slide 19].

Work is also being conducted in the area of neighborhood modeling of urban air toxics, with the goal of using modeled air quality to support human exposure models such as the Stochastic Human Exposure and Dose Simulation (SHEDS) model. Challenges inherent in this effort include: identifying resolutions that are appropriate for separate pollutants or pollutant groups; taking into account the multiple sources present in urban environments; determining the impacts of chemical processes that may affect concentration; and obtaining concentration statistics for assessing human exposure. A prototype of this model will be applied to a study in Philadelphia and the results will be verified using techniques such as computational fluid dynamics modeling. CMAQ would provide more information for input in human population exposure models, as illustrated [slide 24].

In the future, CMAQ will be adapted to address all thirty-three compounds emphasized by NATA by adding one to two compounds per year. Other toxics which may be addressed are inert and involatile metals, halocarbons, and acrolein. More information on CMAQ is available at:

http://www.epa.gov/asmdnerl/models3/cmaq.html

Questions and Discussion with Session III Speakers

Question: Regarding model uncertainty, sometimes there is variability in model parameters that is not uncertainty – it is certain, but still variable.
Response: We did not address variability in model options; on most models, users can select the range of model options. For other parameters, e.g., modeling of emissions, there is uncertainty, not inherent variability.
Comment: [Joe Touma is] working on a study to look at NATA model uncertainty and would welcome assistance from ORD.

Question What is the status of the ISC-PRIME model?
Response: ISC-PRIME deals with down-wash, or high local concentrations, due to the presence of buildings. I believe that you can currently use ISC-PRIME.
Comment: Yes, ISC-PRIME is now available as a technique for down-wash.

Question: When will CMAQ be available for urban scale modeling for all thirty-three toxics?
Response: Possibly in three to four years.

Question: Can you clarify why NATA results show higher concentrations in centroids?
Response: Modeling was conducted at the centroid level and then at smaller scales. At the smaller scale, hot spots were found that were not evident previously.

Question: Why did the uncertainty analysis show higher accuracy for far-field compared to near-field predictions?
Response: This may have only been the case for that one application; we may get different results in subsequent applications.

Question: What would you use for modeling lifetime exposure?
Response: Census tract centroids can be used with the ASPEN model, then another model can be used to convert them to exposure. A comparison can be made between risk numbers and exposure numbers.
Question: Is there a way of doing this that does not require such a convoluted approach?
Response: There are numerous tools available to choose from. A decision must be made on which models to use, followed by comparison of the results.
Comment: CMAQ is just starting to be configured for annual time periods.

Question: How did you account for different species of mercury when comparing observed with predicted deposition?
Response: All wet deposition from the model was aggregated in order to compare it to observed values.

Question: In the urban-scale study, did you compare the average concentration (spatially) in a census tract compared to that in the centroid?
Response: Yes, we will be updating NATA with this information this summer.
Question: Will that change the way NATA data are reported?
Response: It will not change it for the 1999 assessment, since we are reporting distributions.
Comment: A tract centroid is a population weighted location.

Question: Are there any CMAQ developments planned to address sensitivity?
Response: At present, there is nothing standardized on that issue.

Question: [Which factor] is anticipated to produce the most uncertainty in air toxics models?
Response: ORD is conducting research to determine that.
Response: It is difficult to specify that right now; it can also depend on the pollutant being modeled.

Breakout Groups to Discuss Modeling Topics/Questions

During the second breakout session participants were divided into four groups to engage in discussion on any aspect related to modeling. Potential topics and questions to address included:

- How active are the regions in ambient air modeling?
- What types of assessments are being done?
- What are the priorities? What is important?
- Where do the regions want to be with ambient air toxics modeling and skills?
- What obstacles exist? What do the regions need? (Guidance, tools, etc.)
- What is needed to overcome these obstacles?
- Suggested workshop follow-up items.

Following the thirty-minute session, each group presented the major discussion points to the reconvened participants.

Yellow Group

- Application of models: better ways are needed to communicate models and their results to the community and general public. It is necessary to keep models simple and explanations clear and concise.
- Toxicity and regulations rely on model outcomes. When models change, the outcomes also change, and toxicity and regulations are affected. There are many political ramifications to merely improving or changing a model.
- Modeling should continue to be supplemented with monitoring. Combined efforts are needed to improve modeling and to continue to support monitoring.

Blue Group

- Regions need air toxics models and tools. ICS is a model currently in use, although it would benefit from improvement. CMAQ is too experimental and seems to have too many sources of error for use by the regions. It has not been evaluated for air toxics, and was primarily developed to support NATA analysis.
- Regions need models with the ability to accommodate complex parameters (e.g., mountainous terrain). Most regions have technical staff limitations, inhibiting model development and improvement.
- The purpose of models is to determine risk levels, predict future risks, and support monitoring data; these are important functions in risk assessment and risk management.

Red Group

- Air toxics modeling efforts are not a priority for the regions; we need to know what the relative air toxics priorities are.
- Inventories need to be improved. Better data is necessary in order to obtain better, more useable model results. In addition, the data and models should be in an appropriate scale for regional modeling.
- Transportation planning system data must be integrated into air toxics modeling, especially considering the importance of mobile source emissions.
- Consistency among models is important. Developers should ensure that certain data and model standards are met before models can be used and applied.

Green Group

- Concern was expressed regarding the limitations of modeling for the regions. Data limitations can augment the shortcomings of models, such as the unknown effects of retrofits on diesel and other air toxics emissions levels.
- There is a shortage of technical staff involved in model development. Monitoring and modeling personnel are also needed to communicate within and across regions, especially information on what spatial scales modeling is conducted.
- Questions were raised on when community outreach is necessary. Outreach topics or issues include: an explanation of model results; awareness and communication of diesel versus ozone and particulate matter; and immediate versus long-term effects.

THIS PAGE INTENTIONALLY LEFT BLANK

SESSION IV: HUMAN EXPOSURE ASSESSMENT

Co-chairs: Alan VanArsdale (Region 1) and Tim Watkins (ORD/NERL)

Tim Watkins (ORD) introduced Session IV and emphasized its focus on human exposure. Session presentations were planned to give participants an overview of the subject and updates on the topics of indoor and multi-pathway exposure, and the modeling data and tools available. Three human exposure case studies were also presented.

Introduction to Human Exposure – Linda Sheldon (ORD/NERL)

The goal of EPA's air toxics activities is to reduce air pollution emissions in order to improve ambient air conditions. Lower emissions in ambient air should reduce exposure and result in improved human health. Exposure is defined as the contact of an individual with a pollutant for specific time durations, and is the basis for health outcomes. For exposure to occur, an individual must come in contact with a contaminated media; the pollutant from the contaminated media is then transferred to the exposure boundary. This pathway can be used to link the ambient concentration of pollutants to exposure. Exposure can be expressed as aggregate or cumulative – referring to one or multiple stressors, respectively – and results in an absorbed dose. The absorbed dose, or amount of stressor that crosses the body barrier, results in the target dose, or the stressor concentration at the site where effects occur. Biomarkers refer to the concentration of the stressor or a metabolite present in a biological fluid; there is not always a clear relationship between biomarkers and exposure.

Exposure research programs develop methods, data, and models to evaluate the relationship between ambient concentration and exposure; to identify and quantify factors that affect this relationship; and to estimate distributions of exposure and dose. Flow diagrams illustrated the scientific elements of exposure – from the formation of the stressor to health effects – and how exposure relates to the environmental health paradigm [slides 7, 8]. Research on human exposure must determine the extent and possible health effects of exposure, determine ways in which to reduce it, and provide a measure of the success of the study. ORD research on exposure focuses on the development of tools for estimating exposure and dose to address the greatest risks. Exposure characterization for air toxics must take into account sources, fate, and transport of chemicals to determine concentrations in micro-environments. Individual exposure will depend on times spent in these micro-environments, and on the activities and mechanisms responsible for transfer of the stressor or pollutant [slides 11, 12]. Both monitoring and modeling assessment approaches can be used. Exposure models exist which estimate the sum of exposure in all micro-environments and can be used in combination with measurement data or default assumptions [slides 13-15]. Exposure monitoring is used to determine concentrations

and personal activity data, and to characterize attenuation rates and penetration factors of pollutants (e.g., outdoors to indoors). These data can then be used to support modeling studies.

Several such studies have been conducted in past years. The Total Exposure Assessment Methodology (TEAM) studies, conducted in the 1970s, were one of the first attempts to relate personal and ambient exposures. The results revealed personal exposure to be two to three times higher, and prompted the start of a new set of research in that area. Large building studies found VOCs indoors at concentrations three or four times higher than those outdoors. Emissions testing was also conducted to characterize indoor sources, and the Relationship between Indoor, Outdoor, and Personal Air (RIOPA) study combined indoor and ambient monitoring with activity data and other factors that could affect exposure. Commuter studies measured concentrations inside vehicles and compared them to ambient monitoring site values [slide 19]. Future work planned includes a study in Tampa, Florida, to evaluate source to health effects by looking at combined resources from air toxics, asthma, and particulate matter.

Air Toxics Exposure in Indoor Environments – John Girman (OAR/ORIA)

Indoor concentrations of many pollutants can be two to five times higher than outdoors, and numerous activities studies have determined that most individuals spend up to ninety percent of their time indoors. Outdoor air establishes the baseline for indoor concentrations when it penetrates through ventilation systems or direct infiltration. Building materials, consumer products, and occupant activities all add to this baseline to contribute to indoor emissions. As part of an integrated approach to indoor air toxics, the Office of Radiation and Indoor Air (ORIA) is studying the sources and compiling a ranking of all indoor air toxics based on recent exposure data and comparisons of indoor and outdoor concentrations. This is intended to be a screening, risk-based analysis to assist in setting priorities, and utilizes the same methodology used for selecting the thirty-three priority HAPs from outdoor sources. Monitoring data were obtained from studies conducted in the last ten to fifteen years, focusing on typical indoor environments in non-industrial buildings. The study was limited to individual chemicals, and did not consider biological contaminants or chemical mixtures (e.g., tobacco smoke). Both acute and chronic health effects were addressed, assuming exposure by inhalation only. Ten monitoring studies provided 213 concentration records for 112 air toxics including metals, aldehydes, VOCs, and semi-volatile organic carbons (SVOCs). Indoor exposure data were obtained from studies on office buildings, residences, and schools; however, the data used for residences are becoming dated, and only a few intervention studies currently exist for schools.

Concentration data and penetration ratios were presented for the twelve VOCs with the highest median indoor concentration values, obtained from a random survey of office buildings [slides 10, 11]. Wide ranges of concentrations were exhibited by all twelve compounds, with some buildings operating with very low concentrations. Indoor to outdoor ratios were much greater than one (1) in many cases, indicating that some of these compounds have indoor sources (the penetration factors were near one (1) for all compounds). Frequency distributions were also illustrated for three chemicals [slides 12-14]. Tetrachloroethene concentrations increased much faster indoors after the 50^{th} percentile, indicating the presence of important indoor sources. Benzene, its main source being penetration from the outside, showed parallel outdoor and indoor concentrations until the 75^{th} percentile. A terpene used in cleaning products, d-limonene, is almost exclusively an indoor contaminant, and exhibited very low concentrations outdoors. Relative outdoor and indoor concentrations were also presented for a selected list of eighteen air toxics [slide 15]; a surprising result was the high indoors component of a number of pesticides (e.g., aldrin, dieldrin), listed at the far left side of the chart.

The ranking of indoor air toxics has not yet been completed; the study is undergoing peer review by the Science Advisory Board (SAB). However, some air toxics have emerged as likely to be ranked high-priority for indoor air, including aldehydes, benzene, halogenated hydrocarbons, and

pesticides. Data gaps identified in the course of the study include insufficient data for several building types (e.g., schools), and for high exposure areas or hot spots. Health effects data are also lacking as is an inventory of source emissions information.

An integrated approach to air toxics is necessary, particularly when considering exposure. Indoor and outdoor concentrations are interdependent, and exposure to a certain chemical will have the same effects, regardless of source. This integrated approach should not greatly impact ongoing activities and schedules, although the practice of placing monitors on the tops of buildings, where ventilation outlets are located, may need to be examined. Both sources should be considered for effective risk assessment; as for risk management, it may make more sense to apply it to indoor sources where most exposure occurs.

Multi-pathway Exposure Assessment – Matthew Lorber (ORD/NCEA)

Multi-pathway exposure considers not only direct exposure to a contaminant as it is released from the source, but also includes exposure to the same contaminant after it has crossed to different media. Assessment of multi pathway exposures is most often applied to persistent bioaccumulative toxics (PBTs). Although the primary route of exposure to air toxics is by inhalation, indirect exposure through soil, water, and food pathways can be ten to one thousand times higher than direct exposure for some compounds.

In 1990 the *Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions* was published by National Center for Environmental Assessment (NCEA) and provided the first comprehensive set of fate equations and exposure methods for indirect pathways. The first public review draft of the Dioxin Reassessment (1992) revealed that exposure to dioxin from beef consumption exceeded that by inhalation by a factor of four. One year later, that factor of four was cited in an attempt to stop a trial burn at a hazardous waste incinerator, which was followed by an eighteen-month moratorium on permitting of similar incinerators. To obtain a permit, incinerator operators were required to conduct a comprehensive risk assessment for indirect impact, based on an addendum to the 1990 Methodology document. SAB review of the addendum was conducted in 1994, and NCEA took on the task of updating the document and addendum to include SAB comments. Region 4 also required the Columbus Municipal solid waste incinerator to install Maximum Achievable Control Technology (MACT) in 1994, because of concerns regarding dioxin exposures of nearby home-consumption farming families. An update to the draft *Dioxin Reassessment* was also published in 1994 suggesting that the disparity between the inhalation and consumption routes of dioxin exposure was a factor of three rather than four. SAB comments on the document regarding health risk assessment prompted EPA to begin another revision. The *Mercury Report to Congress* (1997) included an exposure assessment and fate modeling data highlighting the complexity in modeling the impacts of this bioaccumulative compound. Subsequent documents included the 1998 *Human Health Risk Assessment Protocol for Hazardous Waste Combustion*; the 1998 update to the 1990 *Multiple Pathways of Exposure* document; and the latest *Dioxin Reassessment* (2000).

Fate and transport models consider atmospheric dispersion, deposition, resuspension and other factors, and predict the movement of contaminants within and between compartments. They incorporate partitioning models that determine how chemicals are partitioned among media in a given environment; mixing models that predict concentrations in stationary receiving media (e.g., soil mixing model); and bioconcentration or biotransfer models that estimate accumulation of contaminants through food webs in animals and humans [slides 9-14].

Multi-pathway exposure assessment scenarios consider subsistence farming and fishing populations to determine the impacts of contaminated soils and water bodies, respectively. Home gardeners are the sub-population chosen as those receiving the baseline or background levels of contaminants. Major pathways include terrestrial animal consumption; soil pathways, including the dermal route of exposure; the breast milk pathway, particularly for lipophilic organic compounds; and others, such as inhalation (direct exposure) or game animal consumption.

A risk assessment study using fate modeling was performed for the Columbus, Ohio Waste-to-Energy Facility (WTEF). In 1992, a decade after beginning operations, the facility was found to emit 980 g TEQ (gram toxic equivalents) per year, compared to 3000 g TEQ per year emitted by all other dioxin sources nationwide. Actions were taken to reduce emissions, and a stack test in 1994 indicated a seventy-five percent decrease. EPA headquarters, ORD, and Region 5 conducted a screening assessment of indirect impacts in that same year, leading to the conclusion that continued emissions "may pose an imminent endangerment to public health and the environment." The Columbus incinerator shut down in December of 1994. Fate modeling used to support the EPA's position utilized the air-to-beef model described in the draft *Dioxin Exposure* document and assumed a subsistence farming family scenario [slides 19, 20]. Exposure pathways considered beef, milk and vegetable ingestion; soil dermal contact and childhood soil ingestion; and breast milk ingestion. The exposure duration for adults was assumed to be seventy years [slide 21]. Air concentrations used were the average from nine dairy farms located between five and twelve miles from the incinerator [slide 22]. Overall exposure and cancer risk were estimated for each of the exposure pathways, with cancer risk being highest for beef consumption ($2*10^{-4}$) and lowest for soil dermal contact ($9*10^{-9}$) [slide 23]. Exposure from breast milk ingestion was determined to be higher by one order of magnitude than exposure from beef and milk consumption, and higher by two orders of magnitude than exposure from inhalation. Breast milk exposure near the incinerator site ranged between two and more than seven times the background dioxin levels [slide 24].

What Human Exposure Data and Models are Available? – Haluk Ozkaynak (ORD/NERL)

Air toxics exposure modeling considers indoor and outdoor sources of pollutants, ambient concentrations, micro-environment concentrations, personal activity data and personal exposure. All of the above factors are inter-related and can be input to or products of models. Types of models include statistical models based on data from personal monitoring studies, and multi-compartment, deterministic models based on known or assumed physical relationships. The latter are more complex, and data are lacking for some of the required parameters, such as outdoor-to-indoor penetration rates. Other models address variability and uncertainty in model structure and input. These include demographics, ambient concentrations, exposure parameters and human activity data. These models use simulated individual profiles to calculate micro-environment concentrations and estimate exposure [slide 5]. The equation for exposure is similar across EPA exposure models and is the time-weighted sum of all exposures from the different micro-environments in which a person spends time [slide 6].

Several databases provide exposure and related information [slides 7-13]:

- U.S. EPA Human Exposure Database System (HEDS) – Exposure database
  http://www.epa.gov/heds/
- Mickey Leland National Urban Air Toxics Research Center (NUATRC) – Exposure database
  http://www.sph.uth.tmc.edu/mleland/
- National Health and Nutrition Examination Survey (NHANES) – Biomonitoring database
  http://www.cdc.gov/nchs/nhanes.htm
- U.S. EPA Aerometric Information Retrieval System (AIRS) – Air Quality Database
  http://www.epa.gov/airs/
- U.S. EPA Consolidated Human Activity Database (CHAD) – Human Activity Database
  http://www.epa.gov/chadnet1/

- U.S. EPA OAQPS National Air Toxics Assessment (NATA) – Exposure Modeling and Results
  http://www.epa.gov/ttn/atw/nata/

Planned National Exposure Research Laboratory (NERL) research includes developing new human exposure and dose estimation models for assessing population health risks and addressing the exposure of susceptible populations. Variability and uncertainty will be explicitly quantified for exposure models and a framework will be developed to accommodate both aggregate and cumulative exposures. NERL's continuing goal in research is to support and enhance science conducted by the program offices. The Air Toxics Multi-Year Plan outlines the development and expansion of the SHEDS model through FY05, and a cumulative population exposure model for a representative set of air toxics by FY08.

The SHEDS model will be designed to quantify both variability (temporal, spatial, or individual differences in the value of an input) and uncertainty (measure of the incompleteness of knowledge or information about an unknown quantity) , and will give an estimate of the confidence intervals associated with the model. Activity patterns for one year will be simulated by using eight people from different age and gender cohorts, and diary entries for one weekday and one weekend day per season [slide 17]. Since age, gender, season, and weekday seem to be the most important variables for longitudinal activity patterns, this approach should optimize inter- and intra-person variability. A commuting algorithm will be included using census tracts and probabilities for work location based on home location, combined with information from a commuting database [slide 18]. Benzene will be used as a case study for the first operation of the SHEDS model, which will include a variety of exposure micro-environments and influential factors [slide 19]. One such factor, in-vehicle exposure, will be estimated using linear regression of data from California roads [slide 21]. Other micro-environments will include parking garages, fueling stations, and areas along streets or sidewalks.

Current research needs include determining more micro-environments and population groups of concern, and measuring or estimating those factors that yield the greatest uncertainty. Personal exposure measurements are also needed for population cohorts that have limited existing data. In the field of model development, mechanistic and stochastic models will be needed to predict source-to-dose relationships, as well as new modeling methods to address high-end exposures to urban air toxics (i.e., hot spots).

Questions and Discussion with Session IV Speakers

Question: What is your reaction to the [chromium] concentrations at 2121 Newton Street, [in the Barrio Logan study]?
Response: I am not very familiar with the study; however, we have some understanding of ultra-fine particles, and there are modeling tools that could be used.
Comment: Working on a similar situation with ambient air around the World Trade Center site, we had to assume that indoor concentrations were equal to those outdoors.
Response: We could take advantage of some of the existing data from Barrio Logan, since it is a good example of looking at individual risk; a study could be done to estimate or model exposure.

Question: Is there a general trend in infiltration rates for particulate matter, as opposed to gases?
Response: Gases, in general, penetrate without much decay. Particulate matter does not penetrate as well.

Question: A commuter study showed higher [outside-to-inside] ratios in Los Angeles than in Sacramento? Why were the ratios different?
Response: The background concentrations are higher in Los Angeles; in Sacramento, the ambient monitoring site was located further away.

Question: There seems to be an infinite number of indoor environments. Is it possible to use a holistic approach?
Response: We essentially take a holistic approach when conducting personal monitoring, by capturing everything that the subjects are exposed to.
Response: An inventory of source emissions from various environments would also be useful. Data are needed in a lot of these categories.
Comment: Characterization of the different types of emissions would be useful, but personal exposure monitoring – especially when combined with activity diaries – is a good way to cover all possible micro-environments. Such monitoring can then be used to go back and check if all micro-environments were captured in the source characterization.

Comment: There seems to be some amplification of chemical concentrations indoors; chlorine is a typical example of this.
Response: Outdoors, an emissions plume will be dispersed over time; concentrations often are higher than expected inside, but should not be higher than outdoor concentrations unless there are additional indoor sources.

Comment: The exposure, however, could be higher because of the time factor; chemicals will linger indoors, rather than disperse.
Comment: Air exchange is another factor to consider along with penetration, particularly for reactive compounds.

Question: In some cases (e.g., in some radon studies) you can put a new family in the same house and have two very different exposures. Is there any information on the fact that the way people live in homes affects their exposure?
Response: In the case of radon, temperature is a factor, as are water traps, so such an effect is not surprising. Other factors such as smoking, hobby activities, or cleaning materials contribute other contaminants. There is potential for educating the public so they are aware of these factors.
Comment: Public education could be an immediate intervention step and would not incur large costs.

Comment: Risk assessors don't always understand the meaning of model results, and it takes a lot of expertise to utilize activity data appropriately. It would be helpful if ORD were to produce a guidance document on how to do this.
Response: Doing an uncertainty and variability analysis can help make this as objective as possible.

Question: Toxicity values don't always match evaluations when we move away from presumptions. Should we be making a greater effort?
Response: Homologous data and measurements are needed for comparisons – to this end, we try to make models as flexible as possible when it comes to input data.

Question: If good data exist on indoor emissions and their toxic components, they could be used to persuade industries to change their products. Are there any plans to pursue this approach?
Response: Market pressures can work in changing consumer products, and the best approach may be to educate consumers. For example, the carpet industry introduced a "green label" program without any input from EPA that has been very successful.
Comment: This is happening already in some industries; a recent study ran into the problem of not being able to find any consumer products left that contained the compound the researchers were interested in. Since products change so rapidly, an inventory may become outdated after only one or two years.

Additional Case Studies: Modeling and Monitoring

Personal Exposure Monitoring Meets Risk Assessment: The South Baltimore Community Exposure Study – Devon Payne-Sturges (OA/OPEI)

The South Baltimore Community Exposure Study was a comparison of measured and modeled exposures and risks in an urban community. The investigation included three different exposure estimation techniques and their impacts on risk estimates and risk characterization. Ambient concentrations modeled by the Assessment System for Population Exposure Nationwide (ASPEN) model have been used by EPA to estimate health risks. However, studies on human exposure have shown discrepancies between ambient concentrations and exposures experienced by individuals; personal exposures are frequently greater than both outdoor and indoor ambient concentrations.

The Brooklyn, Brooklyn Park, and Curtis Bay communities in South Baltimore presented a unique opportunity for this study due to the close proximity of polluting facilities [slide 3]. ASPEN model results (1996) for ambient exposures to twelve VOCs were compared with outdoor, indoor, and personal exposures to the same twelve compounds, in an effort to characterize potential public health risks. Personal exposure monitoring was conducted on thirty-six randomly sampled non-smoking adults using seventy-two-hour weighted exposures and time-activity questionnaires. The twelve VOC samples were all hazardous air pollutants (listed on slide 10). In general, personal exposures were somewhat higher than indoor concentrations and much higher than outdoor concentrations; indoor concentrations were higher than those outdoors [slide 11]. These general trends did, however, vary by compound. Ratios (personal and indoor to outdoor) were near one (1) for compounds with outdoor or ambient sources. Chloroform was one VOC suspected to have significant indoor sources; personal exposure was eleven times outdoor concentrations; indoor concentrations were nine times higher than those outdoors [slide 12]. Ratios of ASPEN to actual exposures were also compared [slides 13, 14]. ASPEN results were considered acceptable when predicted values were within twenty-five percent of actual measurements. ASPEN somewhat overestimated personal benzene exposure, but predicted accurately overall for compounds from primarily outdoor or mobile sources. Personal and indoor exposures to chloroform and methylene chloride, which have significant indoor sources, were under-predicted. These results led to the under-prediction of cancer risk when using the ASPEN model, as opposed to using personal and indoor monitoring data; a four-fold difference was evident between ASPEN cumulative risk predictions and those based on personal monitoring [slide 15]. The relative risk profile from each of the twelve VOCs examined also changed considerably when using ASPEN results versus mean personal exposures; whereas ASPEN predicted benzene to be the biggest contributor (55%) to cumulative

risk, monitoring results revealed that chloroform was more significant, contributing 65% to the total risk [slides 16, 17].

Study results highlighted the need to validate models with actual exposure data, since ambient VOC concentrations did not adequately address health risks. Exposures to VOCs raise concern for public health, and risk assessment performed using modeling and personal exposure monitoring can help prioritize the pollutants that should be targeted for intervention to reduce exposure and risks. The study examined exposure to only a limited number of air pollutants, however, and findings are restricted to those compounds; metals, particulate matter, and diesel PM were not considered, and may change the overall risk picture for the community. It was also assumed that short-term exposures were representative of the long-term. Study strengths were that exposure was measured close to the individual, and that the individuals selected were a population-based random sample. In addition, the cumulative risk analysis provided by the results was more meaningful and provided the context in which the public was interested. Overall, the study confirmed the importance of VOCs as a public health issue. It also served as a way of validating the ASPEN model; the model is a useful tool that predicts ambient concentrations well. Based on the information obtained on indoor sources and exposure to certain VOCs, a recommendation was made to implement a national program requiring manufacturers of consumer products to reveal information about toxic components to consumers. Such a program would not only provide needed information, but may introduce market incentives for manufacturers to substitute less toxic components in their products.

Questions and Comments

Question: There is a tank facility located near the neighborhoods; did the residents indicate that the tank "farms" were the cause of odor problems – particularly during cleaning?
Response: Odors in general have been a problem in the community, and could be from the tank facility or from the wastewater treatment plant located nearby.
Comment: The chemicals used when cleaning such tank facilities have also been a problem.

Question: At what time of year was the sampling conducted?
Response: Sampling was conducted from January 2000 through June 2001.

Question: Chloroform dominated the indoor risk; what would happen if you conducted an uncertainty analysis on those results?
Response: We have not done an uncertainty analysis.
Comment: If the residences were using treated (chlorinated) water, that could be an indoor source of the chloroform.
Response: We don't know if this happens, although it is an issue we plan to examine further.

Question: Were any people from sensitive populations included among the study participants located within the heavy industrial area?
Response: The study was originally planned for residents within that area; however, they were re-located after successful lobbying. Following that, we moved the study to adjacent communities.

Question: What about tobacco smoke?
Response: We limited the study to non-smokers, but we know that some participants were still exposed to environmental tobacco smoke.

Question: What was the public reaction to the results?
Response: The public did understand the representative sampling results. This was a case where we had difficulty recruiting enough people to participate in the study.

Monitoring: Children's Exposure to Diesel School Bus Emissions – David Brown (EHHI/NESCAUM)

This personal exposure study among school children in Connecticut used personal monitoring to estimate the distribution of diesel exposure among children riding school buses and over the duration of a school day. Goals of the study included the identification of factors associated with short term elevations in concentration, and a comparison of the personal exposure findings to Connecticut ambient air levels.

Personal sampling was conducted using fifteen student volunteers from fifteen schools; sampling duration began before the morning bus ride and continued until the end of the afternoon bus ride. Fifteen sample days were collected, and activity logs were kept every fifteen minutes on sample days. Background samples were also taken outside the schools on sample days, as were instantaneous "grab" samples outside the buses. A second phase of the study added measurements on surrogate bus routes for comparison, including rural areas with multiple bus runs; varying numbers of stops, hills, and idling times; and different bus configurations. The latter phase was prompted by the findings of a recent asthma study, which revealed asthma frequencies in rural areas to be as high as those in urban areas, but lower than center cities. Since students from rural areas spend more time per day in school buses [slide 6], it is suspected that their exposure to diesel may be related to the high asthma rates.

Fifteen-minute averages of exposure, as well as continuous exposure of a student during a school day showed a clear trend of high PM_{10} concentrations during the morning and afternoon bus rides [slides 7, 8]. Results from another student showed the same pattern, but included an additional peak at mid-day [slide 9]; this was attributed to students being in a room by the playground at the same time as buses were unloading another group of students there. Median values compiled from nine students monitoring confirmed the exposure to higher concentrations of these volatile organic hydrocarbons while students were in the buses, as opposed to other times during the day [slide 10]. Comparison of ambient versus personal concentrations showed four compounds in common in all monitored student samples: benzene, toluene, 2-butanone, and methyl tertiary butyl ether (MTBE). These samples showed higher concentrations than in nearby background monitors in all cases. For example, MTBE concentrations in personal samples were nearly five times the ambient concentrations [slide 11]. A similar pattern was observed with three carbonyls: formaldehyde, acetaldehyde, and acetone [slide 12]. In this case, acetone concentrations showed a two-fold increase in personal samples as compared to nearby background samples. Ambient data for the state of Connecticut obtained in three-hour intervals also showed an increase in $PM_{2.5}$ concentrations during the morning when buses were operating [slide 13]; this effect was not noticed during the afternoon bus routes, likely because dilutions increased steadily during the course of the day as the air mass was heated. Individual student

exposure to $PM_{2.5}$ was higher than the average daily ambient concentrations for Connecticut in the majority of cases [slide 15], calculated over the same hours.

The second phase of the study identified a number of factors that affect exposures to diesel. Each letter [slide 17] represents a bus. Each bus made multiple circuits of the standardized route over a single day. A certain degree of variability in exposure measures is evident during replicates of the same route by the same bus [slide 17]. Some of this variability depended on whether windows were open or closed when the bus was running [slide 18]. Idling time had a significant effect on increased diesel concentrations, as demonstrated by monitoring of a student who exited a bus and then re-entered after the bus had been idling for ten minutes [slide 19]; upon re-entry, the $PM_{2.5}$ concentration was five times higher than before the student left the bus. The effect of stops en route had a variable effect on exposures, which depended on the time spent idling during stops [slide 20].

Idling buses were a major contributor to diesel PM during school days. The study demonstrated that environmental pollution needs to be more fully characterized, as high individual exposures may be missed by relying on ambient monitoring alone. Stronger collaboration between environmental and public health agencies and advocates is also necessary. Regulatory and policy action may need to be considered in some cases even without an absolute cause and effect association. The state of Connecticut was notified before data from the school bus study were published, and initiated a program to limit idling of school buses. Plans also include retro-fit of the buses and moving loading and unloading zones away from areas where children congregate before and after the school day.

Questions and Comments:

Question: The benzene ambient concentrations seem to be fairly high; are these values typical for Connecticut?

Response: The background sites were located near each school – a different site for each school. They may not be representative or typical of the entire state. Connecticut daily average levels are lower; in an urban/suburban sampling site 24 hour levels of about $0.5ug/m^3$ with 24-hour maximums of about 1.4ug/m3 were reported. Our "background" levels near the schools were for the school day only and may be affected by local sources.

Question: Why were the 75^{th} percentile data used [slide 13, in ambient PM concentrations for Connecticut] rather than the 95^{th} percentile?

Response: Because of the two-hour exposure, if we see respiratory effects, I would expect them to be receptor-mediated. One hour is too short when trying to find relationships between exposure and health responses, such as hospital admissions or asthma attacks. We are trying to look at the 90^{th} and 95^{th} percentile median values as well.

Note: The speaker misunderstood this question. The questioner wondered why 75th percentile values were used rather than 95th to show diurnal trends. The 95th would have shown a stronger peak in the morning due to reduced air mixing. The speaker assumed that one fourth of the days with that mixing reduction would occur.

Comment: Schools are a convenient place to measure children's exposure risk because most of them are there for a large portion of the day; thus, we know or can determine where subjects are for the entire duration of monitoring. They provide a good, "under control" population for experimental measurements.

National Air Toxic Assessment (NATA) – The Initial National Scale Assessment – Ted Palma (OAR/OAQPS)

The National Air Toxic Assessment (NATA) is one of four components of EPA's Air Toxics Program; the National Scale Assessment, part of NATA, is updated every three years. NATA activities include emissions inventories, monitoring, air quality modeling, exposure modeling, and risk characterization, and research on effects and assessment tools. The results of the 1996 assessment were presented in this talk. The initial draft of the 1996 assessment was completed in the summer of 2000, and a detailed document prepared and sent for SAB review in January 2001. The SAB issued its report in December 2001. The assessment was updated to incorporate SAB "short-term" comments and was made public via the EPA NATA website in May 2002.

The National Scale Assessment is a tool that can be used by EPA, states, tribes, and local governments to prioritize resources and data collection and to provide a baseline for tracking trends and measuring progress against goals. It is important to note that the assessment by itself cannot be used as the basis for specific regulatory decisions, but must be combined with local studies. The study considered chronic exposure by inhalation only, based on 1996 emissions data; average exposures were calculated at the census tract level and presented at the county level or higher. The assessment focused on thirty-three urban HAPs including diesel PM [slides 6, 7]; sources of indoor origin were excluded. The components of the assessment included the development of an emissions inventory, modeling (air dispersion and inhalation exposure) compared with both ambient monitoring, risk characterization, and dose-response assessment [slide 8].

The emissions inventory is a crucial part of the assessment and used data from the 1996 National Toxics Inventory (NTI), the 1996 VOC in National Emissions Trends Inventory, and the 1996 Heavy Duty Diesel Rule Inventory. The EMS HAP pre-processor was used to prepare inventory data for the ASPEN model, which provided values for input to the HAPEM4 exposure model [slide 10]. Comparison of ASPEN predictions with monitoring showed that the model predicted benzene accurately, but did poorly for metals [slide 15]. The HAPEM4 model predicts breathing-level concentrations by building a series of activity patterns for representative age and gender cohorts using data from the Consolidated Human Activity Database (CHAD). Cohorts' movements are tracked by the model through one year and thirty-seven micro-environments in order to determine a composite breathing-level concentration. Micro-environment concentrations are determined by the model as a function of ambient concentration, and population exposures are extrapolated from cohort exposures using census population data for each tract. These are important strengths of HAPEM4, as activity patterns show that the majority of people spend very large portions of their time indoors. The model also allows for commuting between tracts, has the capacity for improving predictions by adding information

such as more cohorts (e.g., children) and better activity patterns. HAPEM4, however, is not designed to predict extremes in distribution of exposures; in addition, the model still needs to be fully evaluated against personal monitoring data [slide 20].

HAPEM4 results based on the initial national scale assessment predicted exposure concentrations that were generally lower than the ambient concentrations predicted by ASPEN [slide 21]. On-road mobile gaseous HAPs were an exception, with a predicted exposure of 101% of ambient. Exposures were also calculated for each cohort [slide 22]. Both cancer and non-cancer risk were characterized; median cancer risk (cumulative) was fifty-one per million, with a range from less than one to more than one hundred per million [slides 23, 24]. Cancer risks (average) were also attributed to each compound, as well to different sources of pollutants [slides 25, 26]. National drivers were benzene, chromium, and formaldehyde for cancer, and acrolein for non-cancer effects; several different compounds were identified as regional drivers [slide 27] and contributors [slide 28]. Other compounds were neither risk drivers nor contributors; however, the national assessment alone cannot exonerate HAPs, as it has low resolution and calculates risk based on inhalation only [slide 29]. Diesel exhaust was identified as a likely human carcinogen which could dominate risk from all HAPs. ORD will shortly finalize the Diesel Health Assessment Document. Results from the 1996 National Scale Assessment are available through the NATA website:

http://www.epa.gov/ttn/atw/nata/

A final advisory on the National Scale Assessment was issued by the SAB in December 2001, noting that the effort represented "an important first step towards characterizing the relationships between sources and risks of HAPs." Most SAB comments were provided as recommendations – both short- and long-term – on aspects of the assessment including the inventory, modeling, dose-response, risk characterization, uncertainty, and variability [slide 33, 34]. Future directions for the assessment include a case study in Houston to include indoor and personal monitoring and a variability study; publication of the first in a series of NATA technical documents; and modeling for the 1999 assessment. Ongoing projects include using databases to identify patterns and data gaps, comparing results with local and urban-scale assessments, and promoting the use of results to facilitate planning and data-gathering activities.

Questions and Comments:

Comment: The Agricultural Policy/Environmental eXtender (APEX) or SHEDS model can be used for local-scale assessments.

Question: Why can the model not be validated using actual exposure data?
Response: We can do that, but we are waiting for new data, since we do not want to validate a model with the same data used to develop it.

Question: Workplace exposures can be significant, as people spend forty or more hours at their workplace each week. How are they handled in the national assessment?
Response: Workplace exposure is taken into account in the activity patterns.

THIS PAGE INTENTIONALLY LEFT BLANK

SESSION V: SOURCE APPORTIONMENT

Chair: Chad Bailey (OAR/OTAQ)

Chad Bailey (OAR/OTAQ) began Session V by recapping that participants had thus far been exposed to different types of information on the relationship between exposure and health effects, and to modeling tools helpful in predicting them. The focus of Session V was source apportionment, or source-receptor modeling; presentations included an introduction to tools and methods used in source apportionment, as well as a case study.

Introduction to Source Apportionment Methods – Lynn Hildemann (Stanford University)

The goal of source apportionment is to determine the contributions of pollution sources to a location of interest, using a "receptor"-oriented approach. Commonly used methods include chemical balance modeling (CMB) and two more recently developed methods: principal component analysis (PCA) and positive matrix factorization (PMF).

The chemical mass balance approach uses previously measured emissions compositions from known sources to determine which of the sources have contributed to a sample and to what extent. This technique works only when complete emissions composition information is available for all sources – it cannot be used when source or data are missing. When enough information is available, CMB can be used to analyze single receptor samples and identify specific, well-known sources. Model outputs must be carefully examined, however, to ensure that problems such as missing sources are identified. This approach is also not able to resolve the chemical contributions of sources whose emissions have similar chemical compositions. Tracer species used in CMB must be non-reactive; although trace metals and ions have traditionally been used, recent work has focused on more stable organic aerosol tracers. An example of CMB application is a study that used the technique to attribute ambient concentrations of PM in the Los Angeles area to contributing sources [slides 9, 10].

Principal component analysis (PCA) can be utilized only when numerous receptor samples are available. The model determines which of several "unknown factors" are contributing to the composition of each sample. Expert input is then required, as the model user must decide which factors to retain, and judge what sources are represented by each factor. Occasionally this technique results in negative values for chemical components, or in factors that cannot clearly be connected to sources. Another drawback of the model is that it can yield many potential solutions that cannot be weighed to account for uncertainty. PCA does not require source emission compositions as input, however, and can help identify sources that were not originally

considered as potential contributors. A recent application of PCA used indoor samples from non-smoking residences and assigned emissions to six sources of pollutants [slide 13].

Positive matrix factorization is a recent advance in source apportionment modeling which, like PCA, does not need source compositions as inputs. Also like PCA, it identifies "factors" and their contributions to a receptor sample. Unlike PCA, PMF can account for uncertainties in the input measurements, and can be used even when input data are missing or below the detection limits. In addition, PMF constrains solutions to be greater than zero, avoiding the problem of factors with negative components. A 1999 study using PMF modeling examined 178 personal exposure samples and determined source contributions by regressing PM concentrations against the factors identified by PMF [slides 16, 17].

A table presented [slide 18] summarized the three methods and showed the trade-offs involved in using one versus another. A problem for all methods discussed is the difficulty of distinguishing among sources with similar chemical signatures.

Source Apportionment Tools – Gary Norris (ORD/NERL)

The National Exposure Research Laboratory is currently involved in developing and testing several source apportionment modeling tools, including: a new CMB model expected by November 2002; the EPA Unmix 2.3 model; and the positive matrix factorization (PMF) / Multilinear Engine (ME) model. The latter two models were discussed, and examples of their use in air toxics studies were presented.

Unmix 2.3 performs factor analysis constrained to yield non-negative numbers to generate source profiles (including uncertainties) and source contributions from ambient data. A stand-alone version is available that runs on the Windows 98™ operating system. Unlike PMF models, Unmix 2.3 makes no explicit use of ambient data uncertainties. The user-interface allows input of the number of sources, and provides a "feasible solution" for a set of data. A recent study used hourly PAMS data from El Paso, Texas, and identified gasoline vapor (11%), propane (10%), and non-vehicle emissions (79%) as the three benzene emissions sources and their contributions [slides 5, 6].

Positive matrix factorization was used to perform an analysis of the composition of PM measured in the 1998 EPA Baltimore Exposure Panel study. The exposure study population consisted of elderly subjects residing in a retirement facility in Baltimore, Maryland. Community, outdoor, and indoor samples were taken using the versatile air pollutant sampler (VAPS); additional sampling was conducted using a personal exposure monitor (PEM) for all the above locations as well as apartment and personal monitoring. When PEM samples yielded higher soil and trace element oxide (TEO) concentrations than the VAPS samples, data from the two samplers were analyzed separately [slide 10]. Another surprising finding was a large difference between organic carbon mass concentration collected with a quartz filter and $PM_{2.5}$ collected with the VAPS sampler (Teflon filter) [slide 11]; this difference was attributed to an artifact in measuring. PMF modeling was used to identify the sources of $PM_{2.5}$ contributing to infiltration (outdoors to indoors) and to personal exposure. The average contributions of five sources [slides 13, 14] showed nitrate, sulfate, and motor vehicle exhaust to be the most significant. The contribution of organic carbon was very high (68%), influenced once again by an artifact. The multilinear engine 2 (ME) model was used to identify the sources contributing to personal exposure, ensuring that as much of the observed concentration as possible is explained by external factors [slide 15]. External factors of importance were sulfate, crustal, and an unknown factor. The two major internal factors contributing were a combination of sulfate, silicon, and calcium (possibly wallboard), and a factor similar to outdoor PM in chemical profile; personal care products played a smaller role [slide 17]. The unidentified outdoor PM factor was measured on personal and apartment samples but was absent from the indoor or outdoor stationary monitors. Activity data may have been helpful in resolving uncertainty, e.g.,

time spent in vehicles and outdoors may have explained the outdoor PM contributions to personal exposure [slide 18]. Activity data provided more information on one of the internal factors (wallboard): although the data were used outside the model, they revealed that contribution of this factor increased while residents were dusting and using vacuum cleaners [slide 20].

Planned research stemming from the Baltimore study will examine the organic carbon artifact, and include time-activity data in the receptor model. Regarding personal exposure to motor vehicle PM exhaust, efforts are needed to find a tracer, since lead can no longer be used.

A Modern Example: Northern Front Range Air Quality Study – Chad Bailey (OAR/OTAQ)

The Northern Front Range Air Quality Study (NFRAQS) was conducted in 1996-1997 in the Denver, Colorado urban region as a multi-sponsor research project managed by Colorado State University. Study objectives were to attribute air pollution to sources in order to support air quality management decisions.

Source apportionment focused on carbonaceous aerosol, ammonia (if present), and $PM_{2.5}$. Ambient sites analyzed for carbon (including radioisotopes), ions, and elements (eight sites), as well as for "extended species" to be used for CMB modeling (two sites). Several potential sources were used, including four different types of motor vehicle exhaust profiles [slide 5]. Chemical mass balance modeling was selected because a combination of pre-defined source profiles was available; all sources of analyte species must be included in CMB modeling for accurate results. Motor vehicle exhaust was found to be the largest emissions contributor, followed by ammonium nitrate; dust, debris, and ammonium sulfate had smaller contributions [slide 8]. Apportionment of mobile source emissions revealed gasoline high emitter exhaust and cold start exhaust to be bigger contributors than diesel exhaust [slide 9]. This result was the opposite of inventory findings, which estimated diesel percent contribution at about three times that of gasoline exhaust. NFRAQS results, if accurate, have important implications about mobile source emissions, especially high emitters; the inventory did not consider high emitting or cold start gasoline vehicles, and may be apportioning mobile emissions sources incorrectly. Studies are ongoing to collect more data to check the results of the NFRAQS study.

The use of CMB modeling is the source of some of the limitations of the study. It requires that all sources of model species be characterized; however, the NFRAQS study did not consider non-road engines, and may have overlooked an important, chemically different source (a major rail line). In addition, CMB assumes stable source profiles and the collection and analysis of source and ambient samples by the same means; this poses a problem for mobile sources, as the source is measured at the exhaust, but sampling is ambient. Idling versus driving can also change the exhaust composition.

The NFRAQS study also has implication for human exposure studies. Since CMB requires all sources to be well-analyzed and modeled, factor analysis approaches may be more useful in exposure work until a complete indoor source inventory is available.

Panel Discussion with Session V Speakers

Comment: It seems that there are a lot of diesel engines, and since they last a long time there may also be a time factor to consider.
Response: The longevity of these engines is certainly an issue for consideration.

Question: Are there default systems that allow you to find out how far off you are when using the CMB model – especially if you are missing a source?
Response: There are statistical measures to determine how good a fit your answer is; the expertise of the user has a big role in the decision involved.

Question: Have there been any attempts to bring information on natural gas vehicles to the attention of decision-makers?
Response: The Office of Transportation and Air Quality (OTAQ) has been watching this issue closely, and a major regulation was passed last year to reduce particle emissions.

Question: Why were the indoor and apartment samples different?
Response: Indoor samples were taken from common areas, as opposed to inside individual units.

Question: What was the source of ammonium nitrate in the Denver study?
Response: There was enough ammonium in the atmosphere to convert nitrate to a particulate form.

Question: Would using different classes rather than individual chemicals help simplify source apportionment modeling?
Response: There are methods that can be used to do this, usually as an approach to risk assessment. However, I would be less comfortable assessing risk based on sources.
Comment: If we had a sense of proportion of the risk we could assign it to different categories and use that information in source apportionment studies.
Response: The purpose of source apportionment is to identify chemicals and associate them with sources.
Comment: This type of risk analysis information could be used in terms of personal exposure.

SESSION VI: COMMUNICATING THE RESULTS AND WORKSHOP CONCLUSIONS

Chair: Periann Wood (Region 9)

Periann Wood (Region 9) introduced Captain Alvin Chun – a Captain with the United States Public Health Service on assignment at EPA – who talked about communicating risk assessment and results to the public.

Communicating the Results of Air Toxics Exposure Assessments – Alvin Chun (Region 9)

Communicating scientific results to the public is an important function of government scientists, particularly when it relates to risk from harmful substances. It is usually counter-intuitive to scientists to share initial results with a wide audience, such as a community – especially when those results can be considered "bad news." The first reaction to such findings is to verify them by collecting further data. Although this is a sound scientific approach, it may not be the best option from the perspective of people who might be affected. Delaying the communication of data can give the impression that the government Agency involved is hiding information from the public. Involving the community early (i.e., before the sampling plans have been finalized) also has the advantage of giving them some confidence or awareness of our efforts, and developing a relationship with community representatives, who may serve as allies or liaisons in future public meetings.

Successful meetings require that the experts who are frequently called upon to answer residents' questions be prepared with direct and relevant information and know what to expect. Participants in public meetings may be angry because of losses they may be experiencing, the relevance of the information presented, or they may not understand what the results mean; often, they may not believe the experts' or government representatives' answers. This is likely to happen when the public has not been sufficiently included in the process early on, when scientists are not direct, or do not have enough information to say with certainty what risk assessment results mean for public health. The matter of defining risk is a frequent point of contention: the public may understand "safe" to mean zero risk level, but standards are rarely set at that level. Letting the public know prior to sampling what the standards are and how they relate to risk can be very helpful in building trust and preparing scientists to answer related questions. When limited information is available, safe and unsafe levels should be defined from the start to avoid any perception that levels were set after data was gathered. Action levels outlining what the response will be depending on concentrations found should also be established early, presented, and even negotiated with the public.

In a case study from a community located next to a Superfund site, high levels of vinyl chloride were found near some homes. Vinyl chloride is a Class A carcinogen to which children are particularly susceptible. The regional office did not immediately communicate their findings due to concerns regarding potential uncertainties, and to avoid unnecessary alarm. The community was eventually informed nine months later. A better approach in this situation may have been for EPA to state their concerns about the data and about prematurely frightening the residents; then, present their strategy for determining contaminant levels and the actions that would follow. In addition to earning the trust of the community, early communication offers control to the citizens, provides an opportunity to explain and discuss the need for further study, and request permission to sample inside homes. Confident answers by experts are essential in early intervention meetings, as incomplete or inconsistent answers may give the impression of incompetence. When answers are not immediately available because further study is needed, providing the public with a time line of when these results will be available and offering periodic updates will provide some positive reassurance. Groups who might be especially concerned and whose support and understanding we may need include parents, community leaders, real estate agents, and the County Health Department.

Preparation for involving citizens, such as in meetings or one-to-one visits, can also be enhanced by understanding the losses experienced by people affected – including loss of control, potential loss of health, property value, quality of life, harm to their pets, confidence, and trust in government or county officials. Participants in these meetings may also attend with a pre-conceived perception of government representatives as uninterested, incompetent, or even dishonest. Acknowledging that poor relationships or experiences with government may be commonplace can help government officials accept public anger without taking it personally. Public interactions and meetings can serve as an opportunity to change this opinion over time so that EPA scientists may later be viewed as committed professionals interested in protecting the public and resolving the problem. Seriously listening to concerns when they are dealing with losses is a more effective strategy than interrupting to convey information Although scientists are valued by their peers primarily for their knowledge, the public responds more favorably to representatives who are initially empathetic, open, and honest. Such response will help scientists to understand the problem from the public's perspective, thus earning the trust needed for citizens to consider the scientist's knowledge. Listening to residents' suggestions may also be helpful, as people are familiar with their own community; they may provide useful information, e.g., where to take samples. Once convinced that the interests of the community are a priority for the scientists, members of the public will be more likely to believe and accept or consider their data, opinions, and recommendations.

Questions and Comments

Question: What happens when you know what the community wants or needs, but cannot give it to them?
Response: If you have paid attention to them and established a good rapport, they may be more understanding and accept that you cannot help them.
Comment: Communities/people still want to be respected, even if in the end you cannot help them.

Question: Do you actually tell people that environmental situations are "safe"?
Response: Yes, as long as you explain how you are defining "safe"; or, you can say it without using the word "safe", and yet convey to them that it is acceptable.

Question: In one case, at another Superfund site, action levels were set and communicated to the residents prior to delivering the results to residents. A short time after that, the EPA changed the action levels. How would you deal with that?
Response: You would have to tell the truth and give the reasons for the change, and, in this case, expect a loss of trust and subsequent anger. You may have to negotiate the levels, or actions in order for people to feel reassured. Even following negotiations, the level that you set may be immaterial to the community or more stringent than you had estimated (and if the goal is reassurance, more stringency may be what it takes).
Comment: The community may be aware that an action such as a level change may have been a political decision.
Comment: In a case like this it would be very important to talk to the community frequently during the entire process and even alert them to the things that will influence the final level.

Comment: There has been talk recently of relaxing the EPA's standards for cleaning up buildings.

Conclusions and Next Steps – David Klauder (ORD/OSP)

David Klauder (ORD/OSP) brought the workshop to a close and informed participants that all presentations would be posted on the internet one week after the workshop. The address to the internet site is:

http://epa.gov/osp/regions/workshops.htm

The workshop planning group was acknowledged for preparing a successful meeting.

One of the goals of this workshop was to build networks that will lead to long-term Region/ORD partnerships and collaborative projects. The closing discussion centered on the generation of ideas for activities for possible follow-up activities among workshop participants that would further these goals. The following is a summary of these ideas.

Suggested Follow-Up Actions

High Priority Research and Research Product Needs

- Greater Regional participation in the August 2002 revision of the Air Toxics Multi-year Plan (MYP) and possibly other ORD-led research planning activities *(Randy Robinson)*.
- Identify opportunities to address critical methods development needs *(Ken Mitchell)*.
- Develop tools for community-level assessments and research that would improve these tools *(Paul Shapiro & Ken Mitchell)*.

Technology Transfer

- Enhance the utility of the National Guidance Document as a technical resource manual to the Regions *(Paul Shapiro & Ken Mitchell)*.
- Broader Agency involvement in the Regional Urban Air Toxics Initiative pilot program to help identify tools for community-level assessments *(Pam Tsai)*.
- Conduct workshops and/or training sessions on the application and interpretation of results from specific methods, models, and other tools presented in this workshop *(Joe Touma & Randy Robinson)*.
- Conduct follow-up workshops on related topics, e.g., exposure modeling, air risk assessment, diesel emissions and other mobile sources *(from Evaluation Sheets)*.

Communications

- Create an Agency expert directory for key Air Toxics science topics *(Alan VanArsdale)*.
- Improve mechanisms, e.g., EPA web links and Agency Science Inventory, for informing interested Agency scientists about existing products and relevant research, including how people are using data and tools *(Haluk Ozkaynak)*.
- Greater cross-Agency involvement on existing air toxics conference calls, e.g. the air toxics monitoring call organized by Motria Poshyvanyk *(Paul Shapiro)*.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A: AGENDA

Region/ORD/OAR Workshop on Air Toxics Exposure Assessment
EPA Region 9 Office, 75 Hawthorne St., San Francisco, CA
June 25-27, 2002

Workshop to Focus on Two General Exposure Assessment Questions:

1. What is our inhalation exposure to toxic chemicals of concern in our Region (at a "screening level of certainty")?

2. What is our inhalation exposure to toxic chemicals of concern in our community (at a "high level of certainty")?

JUNE 25th - *MORNING*

8:30 AM - 9:45 AM Welcome and Introduction

8:30 Welcome - Jack Broadbent, Director (Air Division - Region 9), Larry Cupitt, Acting Associate Director of Health (ORD/NERL), and Winona Victery (Region 9)

8:45 Overview of Exposure Assessments - Ken Mitchell (Region 4) and Tim Watkins (ORD/NERL)

9:45 AM - 12:30 PM Session I: Designing an Air Toxics Exposure Assessment - Monitoring vs. Modeling
Co-chairs: Ken Mitchell (Region 4), Paul Shapiro (ORD/NCER), and Ted Palma (OAR/OAQPS)

9:45 *Monitoring vs. Modeling - An Interactive Group Exercise:* Paul Shapiro (ORD/NCER) and Ted Palma (OAR/OAQPS)

10:15 BREAK

10:30 Case Studies to Illustrate Uses of Monitoring and Modeling
MATES II - A Regional Perspective: Mike Nazemi (South Coast Air Quality Management District)
Minneapolis - St. Paul - A Comparison of Community, Residential, and Personal Exposure: John Adgate (University of Minnesota)

12:30 LUNCH

JUNE 25th - *AFTERNOON*

1:30 PM - 2:30 PM Session I: Designing an Air Toxics Exposure Assessment - Monitoring vs. Modeling (cont'd)

1:30 Expert Panel
Mike Nazemi (SCAQMD)
John Adgate (UMN)
John Girman (OAR/ORIA)
Larry Cupitt (ORD/NERL)
Neil Frank (OAR/OAQPS)
Matt Lorber (ORD/NCEA)
Joe Touma (OAR/OAQPS)

2:30 PM - 5:30 PM Session II: Monitoring Methods and Network Design
Co-chairs: Motria Poshyvanyk (Region 5), Neil Frank (OAR/OAQPS), and Tim Watkins (ORD/NERL)

2:30 *Air Toxics Monitoring Pilot Project*: Barbara Morin (Department of Environmental Management, Rhode Island)

3:00 *New Trends in Monitoring Methods*: Tim Watkins (ORD/NERL) (for Don Whitaker)

3:30 BREAK

3:45 *Atmospheric Formation and Decay of Air Toxics - Implications for Exposure Assessments*: Deborah Luecken (ORD/NERL)

4:30 *Air Toxics Monitoring Methods and Network Design*
Steve Bortnick and Shannon Stetzer (Battelle Memorial Institute)

5:15 General Discussion

5:30 Adjourn to *Thirsty Bear* (brew pub next to the Region 9 meeting room)

JUNE 26th - *MORNING*

8:30 AM - 12:00 PM Session II: Monitoring Methods and Network Design (cont'd)

8:30 California Monitoring Program: Statewide Network to the Neighborhood Scale
Jeff Cook and Linda Murchison (California Air Resources Board)

10:00 BREAK

10:15 Design Your Own Air Toxics Monitoring Network (an interactive group exercise)
Motria Poshyvanyk (Region 5) - lead

12:00 LUNCH

JUNE 26th - *AFTERNOON*

1:00 PM - 5:30 PM Session III: Modeling Tools - Current and Future
Co-chairs: Randall Robinson (Region 5), Joe Touma (OAR/OAQPS), and Tim Watkins (ORD/NERL)

1:00 *Air Quality Models*: Joe Touma (OAR/OAQPS)

1:15 *Using Emission Inventories for Air Quality Modeling*: Joe Touma (OAR/OAQPS)

1:30 Model Applications
A. *Local Scale - Barrio Logan Modeling Analysis*: Vlad Isakov (California Air Resources Board)

2:00 B. *Urban Scale Modeling - Houston Case Study:* Joe Touma (OAR/OAQPS)

2:30 *Applying CMAQ Models3 for Air Toxics Assessments:* Bill Hutzell (ORD/NERL)

3:00 Q & A with Speakers

3:30 BREAK

3:45 Breakouts to Discuss Modeling Questions – Potential Topics:

* How active are the Regions in ambient air modeling?
* What types of assessments are being done?
* What are the priorities? What is important?
* Where do the Regions want to be with ambient air toxics modeling and skills?
* What obstacles exist? What do the Regions need? Guidance? Tools? Etc.
* What is needed to overcome these obstacles?
* Suggested workshop follow-up items.

5:00 Breakout Reports and Wrap Up Discussion
5:30 Adjourn

JUNE 27th - *MORNING*

8:00 AM - 12:00 PM Session IV: Human Exposure Assessment
Co-chairs: Alan VanArsdale (Region 1) and Tim Watkins (ORD/NERL)

8:00 *Introduction to Human Exposure:* Linda Sheldon (ORD/NERL)

8:30 *Air Toxics Exposure in Indoor Environments*: John Girman (OAR/ORIA)

8:50 *Multi-pathway Exposure Assessment*: Matthew Lorber (ORD/NCEA)

9:10 *What Human Exposure Data and Models are Available?*: Haluk Ozkaynak (ORD/NERL)

9:30 Q & A with Speakers

10:00 BREAK

10:15 Additional Case Studies:
A. *Personal Exposure Monitoring Meets Risk Assessment: The South Baltimore Community Exposure Study:* Devon Payne-Sturges (OA/OPEI)

10:50 B. *Monitoring: Children's Exposure to Diesel Emissions*: David Brown (NESCAUM)

11:25 C. *Modeling: National Air Toxic Assessment (NATA) – The Initial National Scale Assessment:* Ted Palma (OAR/OAQPS)

12:00 LUNCH

JUNE 27th - *AFTERNOON*

1:00 PM - 2:30 PM Session V: Source Apportionment
Chair: Chad Bailey (OAR/OTAQ)

1:00 *Introduction to Source Apportionment Methods*: Lynn Hildemann (Stanford University)

1:20 *Source Apportionment Tools*: Gary Norris (ORD/NERL)

1:50 *Case Study: A Modern Example: Northern Front Range Air Quality Study*: Chad Bailey (OAR/OTAQ)

2:10 Panel Discussion with Speakers

2:30 BREAK

2:45 PM - 4:30 PM Session VI: Communicating the Results and Workshop Conclusions
Chair: Periann Wood (Region 9)

2:45 *Communicating the Results of Air Toxics Exposure Assessments*: Alvin Chun (Region 9)

4:00 Conclusions and Next Steps - Winona Victery (Region 9) and David Klauder (ORD/OSP*)*

4:30 Adjourn

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B: LIST OF PARTICIPANTS

EPA Regional Offices

Beth Antley (Attendee)
Region 4
980 College Station Rd.
Athens, GA 30605
Tel: 706-355-8620
Fax: 706-355-8744
E-mail: antley.beth@epa.gov

Mike Bandrowski (Attendee)
Region 9 (AIR-6)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4194
Fax: 415-947-3583
E-mail: bandrowski.mike@epa.gov

Thomas Baugh (Attendee)
U.S. EPA, ORA
Region 4 (14th Floor)
61 Forsyth St. SW
Atlanta, GA 30303
Tel: 404-562-8275
Fax: 404-562-8269
E-mail: baugh.thomasL@epa.gov

Carol Bellizzi (Attendee)
Region 2
290 Broadway
New York, NY 10007-1866
Tel: 212-637-3712
Fax: 212-637-3901
E-mail: bellizzi.carol@epa.gov

Carol Bohnenkamp (Attendee)
Region 9 (AIR-7)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4130
Fax: 415-947-3579
E-mail: bohnenkamp.carol@epa.gov

Scott Bohning (Attendee)
Region 9 (AIR-7)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4127
Fax: 415/947-3579
E-mail: bohning.scott@epa.gov

Stacy Braye (Attendee)
Region 9 (WST-4)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3345
Fax: 415-947-3533
E-mail: braye.stacy@epa.gov

Jack Broadbent (Speaker)
Region 9 (AIR-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4141
E-mail: broadbent.jack@epa.gov

John Brock (Attendee)
Region 9 (AIR-5)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3999
Fax: 415-947-3579
E-mail: brock.john@epa.gov

Catherine Brown (Attendee)
Region 9 (AIR-7)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4137
Fax: 415-947-3579
E-mail: brown.catherine@epa.gov

Nicole Buffa (Attendee)
Region 9 (CMD4-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4161
E-mail: buffa.nicole@epa.gov

Ray Chalmers (Attendee)
Region 3 (3AP11)
1650 Arch St.
Philadelphia, PA 19103-2029
Tel: 215-814-2061
Fax: 215-814-2134
E-mail: chalmers.ray@epa.gov

Tai-Ming Chang (Attendee)
Region 9 (CMD-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3831
E-mail: chang.tai-ming@epa.gov

Alvin Chun, Captain (Speaker)
Region 9 (AIR-6)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4190
Fax: 415-947-3583
E-mail: chun.alvin@epa.gov

Kuenja Chung, Ph.D. (Attendee)
Region 6 (6pdq)
Air Quality Analysis Section
1445 Ross Ave.
Dallas, TX 75202
Tel: 214-665-8345
Fax: 214-665-6762
E-mail: chung.kuenja@epa.gov

Larry Cupitt, Ph.D. (Speaker)
Region 4 (D305-01)
109 T.W. Alexander Dr.
Research Triangle Park , NC 27709
Tel: 919-541-0349
Fax: 919-541-3615
E-mail: cupitt.larry@epa.gov

Bruni Davila (Attendee)
Region 9 (SFD7-4)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3162
E-mail: davila.brunilda@epa.gov

Richard Daye (Attendee)
Region 7
901 North 5th St.
Kansas City, KS 66101
Tel: 913 551-7619
Fax: 913 551-9619
E-mail: daye.richard@epa.gov

Dana Dean (Attendee)
Region 9
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3872
E-mail: dean.dana@epa.gov

Lynda Deschambault (Attendee)
Region 9 (CMD4-2)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4183
Fax: 415-947-3583
E-mail: deschambault.lynda@epa.gov

Kathy Diehl, MSE (Attendee)
Region 9 (AIR-8)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415 972-3996
Fax: 415 947-3579
E-mail: diehl.kathy@epa.gov

Sylvia Dugre (Attendee)
Region 9 (AIR-2)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4149
Fax: 415-947-3579
E-mail: dugre.sylvia@epa.gov

Todd Ellsworth (Attendee)
Region 3 (3AP21)
1650 Arch St.
Philadelphia, PA 19103-2029
Tel: 215-814-2195
Fax: 215-814-2124
E-mail: ellsworth.todd@epa.gov

Gwen Eng (Attendee)
ATSDR
Region 9 (HHS-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4317
Fax: 415-947-4323
E-mail: eng.gwen@epa.gov

Danny France (Attendee)
Region 4
980 College Station Rd.
Athens, GA 30605
Tel: 706-355-8738
Fax: 706-355-8744
E-mail: france.danny@epa.gov

Gerald Hiatt, Ph.D. (Attendee)
Region 9 (SFD-8B)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3064
Fax: 415-947-3518
E-mail: hiatt.gerald@epa.gov

Ofia Hodoh (Attendee)
Region 4
61 Farsyth Street, SW
Atlanta, GA 30303
Tel: 404-562-9176
Fax: 404-562-9095
E-mail: hodoh.ofia@epa.gov

Peter Kahn (Attendee)
Region 1 (ECA)
11 Technology Dr.
North Chelmsford, MA 01863
Tel: 617-918-8392
Fax: 617-918-8417
E-mail: kahn.peter@epa.gov

Jeff KenKnight (Attendee)
OAQ
Region 10 (OAQ-107)
1200 Sixth Ave.
Seattle, WA 98101
Tel: 206-553-6641
Fax: 206-553-0110
E-mail: kenknight.jeff@epa.gov

Robert Kotchenruther, Ph.D. (Attendee)
Region 10 (OEA-095)
1200 Sixth Ave
Seattle, WA 98101
Tel: 206-553-6218
Fax: 206-553-8210
E-mail: kotchenruther.robert@epa.gov

Richard Lessler, Ph.D (Attendee)
Region 9 (AIR-6)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4197
Fax: 415-947-3583
E-mail: lessler.richard@epa.gov

Libby Levy (Attendee)
ATSDR
Region 9 (HHS-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4319
Fax: 415-947-4323
E-mail: levy.libby@epa.gov

Brook Madrone (Attendee)
Region 10 (OAQ-107)
1200 6th Ave.
Seattle, WA 98101
Tel: 206-553-1814
Fax: 206-553-0110
E-mail: madrone.brook@epa.gov

Kenneth Mitchell, Ph.D. (Speaker)
Region 4
61 Forsyth St., SW
Atlanta, GA 30303
Tel: 404-562-9065
Fax: 404-562-9095
E-mail: mitchell.ken@epa.gov

William Nelson (Attendee)
ATSDR
Region 9 (HHS-1)
75 Hawthorne St., Suite 100
San Francisco, CA 94105
Tel: 415-947-4316
Fax: 415-947-4323
E-mail: wqn1@cdc.gov

Phuong Nguyen (Attendee)
Region 5 (AR- 18J)
77 West Jackson Blvd.
Chicago, IL 6064
Tel: 312-886-6701
Fax: 312-886-5824
E-mail: nguyen.phuong@epa.gov

Francis O'Neill (Attendee)
Region 6 (6MD-HA)
10625 Fallstone Rd.
Houston, TX 77099-4303
Tel: 281 983 2181
Fax: 281 983 2248
E-mail: oneill.francis@epa.gov

Cheryl Overstreet (Attendee)
Region 6 (6PD-NB)
1445 Ross Ave.
Dallas, TX 75202
Tel: 214-665-6643
Fax: 214-665-7263
E-mail: overstreet.cheryl@ epa.gov

Coe Owen (Attendee)
Region 9 (AIR-7)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4134
Fax: 415-947-3579
E-mail: owen.coe@epa.gov

Motria Poshyvanyk (Organizer)
Region 5 (AR-18J)
77 West Jackson Blvd.
Chicago, IL 60604
Tel: 312-886-0267
Fax: 312-886-5824
E-mail: poshyvanyk.motria@epa.gov

Randy Robinson (Organizer)
Region 5 (AR-18J)
Metcalfe
77 West Jackson Blvd.
Chicago, IL 60604
Tel: 312-353-6713
Fax: 312-886-0617
E-mail: robinson.randall@epa.gov

Keith Rose, Ph.D. (Attendee)
Region 10 (OAQ-107)
1200 Sixth Ave.
Seattle, WA 98101
Tel: 206-553-1949
Fax: 206-553-0110
E-mail: rose.keith@epa.gov

Margaret Sieffert (Attendee)
Region 5 (AR-18J)
77 West Jackson Blvd.
Chicago, IL 60604
Tel: 312-353-1151
Fax: 312-886-0617
E-mail: sieffert.margaret@epa.gov

Michael Sivak (Attendee)
Region 2
290 Broadway, 18th Floor
New York, NY 10007
Tel: 212-637-4310
Fax: 212-637-4360
E-mail: sivak.michael@epa.gov

MaryBeth Smuts, Ph.D. (Attendee)
Region 1 (CAP)
Suite 1100
One Congress St.
Boston, MA 02114
Tel: 617-918-1512
Fax: 617-918-1505
E-mail: smuts.marybeth@epa.gov

Wienke Tax (Attendee)
Region 9 (AIR-2)
P.O. Box 86825
Tucson, AZ 85754-6825
Tel: 520-622-1622
Fax: 520-622-1622
E-mail: tax.wienke@epa.gov

Barbara Toole O'Neil (Attendee)
Region 9 (Air-5)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3991
Fax: 415-947-3579
E-mail: tooleoneil.barbara@epa.gov

Pam Tsai, Sc.D. (Attendee)
Region 9 (Air-6)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4196
Fax: 415-947-3583
E-mail: tsai.pam@epa.gov

Alan VanArsdale (Attendee)
Region 1 (ECA)
New England Regional Lab.
11 Technology Dr.
North Chelmsford, MA 01863
Tel: 617-918-8610
Fax: 617-918-9397
E-mail: vanarsdale.alan@epa.gov

Winona Victery, Ph.D. (Organizer)
Region 9 (PMD-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3736
Fax: 415-947-3558
E-mail: victery.winona@epa.gov

Lawrence Wapensky (Attendee)
Region 8 (8P-AR)
999 18th St.
Denver, CO 80202
Tel: 303-312-6043
Fax: 303-312-6064
E-mail: wapensky.lawrence@epa.gov

Patrick Wilson, Ph.D., M.P.H (Attendee)
Region 9 (WST-5)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3354
Fax: 415-947-3530
E-mail: wilson.patrick@epa.gov

Periann Wood, Ph.D. (Attendee)
Region 9 (A -7)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-947-4187
Fax: 415-947-3583
E-mail: wood.periann@epa.gov

Jeff Woodlee, CIH (Attendee)
Health & Safety
Region 9 (PMD2-1)
75 Hawthorne St.
San Francisco, CA 94105
Tel: 415-972-3740
Fax: 415-947-3558
E-mail: woodlee.jeff@epa.gov

Other EPA Offices

Chad Bailey (Speaker)
OAR (ASD/ATC)
2000 Traverwood Dr.
Ann Arbor, MI 48105
Tel: 734-214-4954
Fax: 734-214-4939
E-mail: bailey.chad@epa.gov

Barbara Driscoll (Attendee)
U.S. EPA /OAQPS, ESD/PPSG
OAR (C439-04)
Research Triangle Park, NC 27711
Tel: 919-541-1051
Fax: 919-541-0942
E-mail: driscoll.barbara@epa.gov

Neil Frank, Ph.D. (Speaker)
OAR © 304-01)
Research Triangle Park, NC 27711
Tel: 919-541-5560
Fax: 919-541-3613
E-mail: frank.neil@epa.gov

John Girman (Speaker)
OAR (6609J)
1200 Pennsylvania Ave, NW
Washington, DC 20460
Tel: 202-564-9317
Fax: 202-565-2071
E-mail: girman.john@epa.gov

David Guinnup, Ph.D. (Attendee)
U.S. EPA/OAQPS
OAR (C404-01)
Research Triangle Park, NC 27711
Tel: 919-541-5368
Fax: 919-541-0840
E-mail: guinnup.dave@epa.gov

Barbara Morin (Speaker)
RI DEM
OAR
235 Promenade St.
Providence, RI 02908
Tel: 401-222-2808
Fax: 401-222-2017
E-mail: bmorin@dem.state.ri.us

Peter Murchie (Attendee)
U.S. EPA
OAR
811 SW 6th Ave, 3rd Floor
Portland, OR 97204
Tel: 503-326-6554
Fax: 503-326-3399
E-mail: murchie.peter@epa.gov

Ted Palma (Speaker)
OAR (C404-01)
Bldg. C
Research Triangle Park, NC 27711
Tel: 919-541-5470
Fax: 919-541-0840
E-mail: palma.ted@epa.gov

Devon Payne-Sturges, DrPH (Speaker)
OA (1809T)
Ariel Rios
1200 Pennsylvania Ave., NW
Washington , DC 20460
Tel: 202-566-2316
Fax: 202-566-2363
E-mail: payne-sturges.devon@ epa.gov

Henry Topper (Attendee)
OPPTS
701 Spencer Ave
Santa Rosa, CA 95404
Tel: 707-292-6637
Fax: 202-564-8750
E-mail: topper.henry@epa.gov

Joe Touma (Speaker)
OAR (D243-01)
Research Triangle Park, NC 27711
Tel: 919-541-5381
Fax: 919-541-0044
E-mail: touma.joe@epa.gov

Office of Research and Development (ORD)

William Boyes, Ph.D. (Attendee)
NHEERL
ORD (MD-74b)
ERC
86 Alexander Dr.
Research Triangle Park, NC 27711
Tel: 919-541-7538
Fax: 919-541-3335
E-mail: boyes.william@epa.gov

Janet Burke, Ph.D. (Attendee)
ORD (E205-02)
109 Alexander Dr.
Research Triangle Park, NC 27711
Tel: 919-541-0820
Fax: 919-541-7953
E-mail: burke.janet@epa.gov

Robert Fegley (Attendee)
ORD (8104R)
Reagan Bldg.
1200 Pennsylvania Ave, NW
Washington, DC 20460
Tel: 202-564-6786
Fax: 202-565-2915
E-mail: fegley.robert@epa.gov

Stephen Graham, Ph.D. (Attendee)
ORD (E-205-2)
109 T.W. Alexander Dr.
Research Triangle Park, NC 27709
Tel: 919-541-4344
Fax: 919-541-7953
E-mail: graham.stephen@epa.gov

Bill Hutzell, Ph.D. (Speaker)
ORD (E243-03)
Research Triangle Park, NC 27711
Tel: 919-541-3425
Fax: 919-541-1379
E-mail: hutzell.bill@epa.gov

David Klauder, Ph.D. (Organizer)
ORD (8104)
Reagan Bldg.
1300 Pennsylvania Ave., NW
Washington, DC 20460
Tel: 202-564-6496
Fax: 202-565-2915
E-mail: klauder.david@epa.gov

Matthew Lorber (Speaker)
NCEA
ORD (8623D)
1300 Pennsylvania Ave., NW
Washington, DC 20460
Tel: 202-564-3243
Fax: 202-565-0078
E-mail: lorber.matthew@epa.gov

Deborah Luecken (Speaker)
ORD (E205-02)
109 T.W. Alexander Dr.
Research Triangle Park, NC 27711
Tel: 919-541-0244
Fax: 919-541-7953
E-mail: luecken.deborah@epa.gov

Gary Norris, Ph.D. (Speaker)
U.S. EPA/NERL
ORD (E205-03)
Research Triangle Park, NC 27711
Tel: 919-541-1519
Fax: 919-541-0960
E-mail: norris.gary@epa.gov

Haluk Ozkaynak, Ph.D. (Speaker)
ORD (MC-8601D)
Ariel Rios
1200 Pennsylvania Ave, NW (Rm. 620W5)
Washington, DC 20460
Tel: 202-564-1531
Fax: 202-565-0075
E-mail: ozkaynak.haluk@epa.gov

Paul Shapiro (Organizer)
ORD (8722R)
Reagan Bldg.
1200 Pennsylvania Ave., NW
Washington, DC 20460
Tel: 202-564-6833
Fax: 202-565-2447
E-mail: shapiro.paul@epa.gov

Linda Sheldon, Ph.D. (Speaker)
HEASD/ NERL
ORD (E205-01)
109 T.W. Alexander Dr.
Research Triangle Park, NC 27709
Tel: 919-541-2454
Fax: 919-541-0239
E-mail: sheldon.linda@epa.gov

Tim Watkins (Organizer)
ORD (D305-01)
Research Triangle Park, NC 27711
Tel: 919-541-5114
Fax: 919-541-0715
E-mail: watkins.tim@epa.gov

Invited Guests

John Adgate, Ph.D. (Speaker)
University of Minnesota
(MMC 807)
Mayo 1260
420 Delaware St. SE
Minneapolis, MN 55455
Tel: 612-624-2601
Fax: 612-626-0650
E-mail: jadgate@umn.edu

Judith Blair (Attendee)
Maresh Brains at Work
4313 Apple Way
Boulder, CO 80301
Tel: 303-545-2259
Fax: 303-444-7213
E-mail: judith@brainsatwork.com

Steven Bortnick, Ph.D. (Speaker)
Battelle Memorial Institute
505 King Ave.
Columbus, OH 43201-2693
Tel: 614-424-7487
Fax: 614-424-4250
E-mail: bortnick@battelle.org

David Brown, Sc.D. (Speaker)
NESCAUM/ EHHI
65 Bulkley Ave. (North)
Westport, CT 06880
Tel: 203-259-5698
Fax: 203-256-8799
E-mail: dbrown@nescaum.org

Michael Coggiola, Ph.D. (Attendee)
SRI International
333 Ravenswood Ave.
Menlo Park, CA 94025
Tel: 650-859-3045
Fax: 650-859-6196
E-mail: michael.coggiola@sri.com

Jeff Cook (Speaker)
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812
Tel: 916-322-3726
Fax: 916-327-8217
E-mail: jcook@arb.ca.gov

Lynn Hildemann, Ph.D. (Speaker)
Stanford University
Terman Engineering Center, Rm. M-5
Stanford, CA 94305-4020
Tel: 650-723-0819
Fax: 415-947-3583
E-mail: hildemann@ce.stanford.edu

Vlad Isakov, Ph.D. (Speaker)
California Air Resources Board
1001 I St.
Sacramento, CA 95812
Tel: 916-445-2151
Fax: 916-327-8524
E-mail: visakov@arb.ca.gov

Nancy Maresh (Attendee)
Maresh Brains at Work
4313 Apple Way
Boulder, CO 80301
Tel: 303-545-2259
Fax: 303-444-7213
E-mail: nancy@brainsatwork.com

Linda Murchison, Ph.D. (Speaker)
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812
Tel: 916-322-5350
Fax: 916-323-1075
E-mail: lmurchis@arb.ca.gov

Mike Nazemi (Speaker)
S. Coast Air Quality Mgmt. District
(PRDAS)
21865 E. Copley Dr.
Diamond Bar, CA 91765
Tel: 909-396-3187
Fax: 909-396-3252
E-mail: mnazemi@aqmd.gov

Todd Sax, M.S. (Attendee)
California Air Resources Board
1001 I St., PO Box 2815
Sacramento, CA 95821
Tel: 916-322-6159
Fax: 916-323-1075
E-mail: tsax@arb.ca.gov

Shannon Stetzer (Speaker)
Battelle Memorial Institute
505 King Ave.
Columbus, OH 43201
Tel: 614-424-6575
Fax: 614-424-4250
E-mail: stetzers@battelle.org

Jed Waldman (Attendee)
CA Dept. of Health Services
2151 Berkeley Way (EHLB)
Berkeley, CA 94704
Tel: 510-540-3427
Fax: 916-440-5855
E-mail: jwaldman@dhs.ca.gov

APPENDIX C: SLIDES FROM PRESENTATIONS

These slides can be found at
http://epa.gov/osp/regions/workshops.htm

1.	*Air Toxics Exposure Assessment Workshop - Welcome*	**Larry Cupitt**
2.	*Exposure Assessment and Air Toxics*	**Ken Mitchell**
3.	*Overview of Air Toxics Exposure Assessment in ORD*	**Tim Watkins**
4.	*MATES II - A Regional Perspective*	**Mike Nazemi**
5.	*Minneapolis-St. Paul - A Comparison of Community, Residential, and Personal Exposure*	**John Adgate**
6.	*Air Toxics Monitoring Pilot Project*	**Barbara Morin**
7.	*New Trends in Monitoring Methods*	**Don Whitaker**
8.	*Atmospheric Formation and Decay of Air Toxics - Implications for Exposure Assessments*	**Deborah Luecken**
9.	*Air Toxics Monitoring Methods and Network Design*	**Steve Bortnick and Shannon Stetzer**
10.	*California Monitoring Program: Statewide Network to the Neighborhood Scale*	**Jeff Cook and Linda Murchison**
11.	*Design Your Own Air Toxics Monitoring Network*	**Motria Poshyvanyk**
12.	*Air Quality Models*	**Joe Touma**
13.	*Using Emission Inventories for Air Quality Modeling*	**Joe Touma**
14.	Barrio *Logan Modeling Analysis*	**Vlad Isakov**
15.	*Urban Scale Modeling - Houston Case Study*	**Joe Touma**
16.	*Applying CMAQ Models3 for Air Toxics Assessments*	**Bill Hutzell**
17.	*Introduction to Human Exposure*	**Linda Sheldon**
18.	*Air Toxics Exposure in Indoor Environments*	**John Girman**

19. *Multi-pathway Exposure Assessment* **Matthew Lorber**
20. *What Human Exposure Data and Models are Available?* **Haluk Ozkaynak**
21. *Nation Air Toxics Assessment (NATA) - The Initial National Scale Assessment* **Ted Palma**
22. *Children's Exposure to Diesel Emissions* **David Brown**
23. *Personal Exposure Meets Risk Assessment: The South Baltimore Community Exposure Study* **Devon Payne-Sturges**
24. *Introduction to Source Apportionment Methods* **Lynn Hildemann**
25. *Source Apportionment Tools* **Gary Norris**
26. *A Modern Example: Northern Front-Range Air Quality Study* **Chad Bailey**
27. *Communicating the Results of Air Toxics Exposure Assessments* **Alvin Chun**

APPENDIX D: FLIP CHART NOTES

Breakout Session I: Design Your Own Air Toxics Monitoring Network (Day 2)

Goals / Objectives:

Design an Air Toxics Monitoring Network

- Groups #1 (Yellow) and #2 (Blue): Design an Air Toxics Monitoring Network in a Large-Scale Urban Area
- Groups #3 (Red) and #4 (Green): Design an Air Toxics Monitoring Network in a Small-Scale Local Hotspot

Group # 1 (Yellow)

Attendees:

Baugh, Thomas	Region 4
Blair, Judith	Maresh Brains at Work
Brown, Catherine	Region 9
Cook, Jeff	California Air Resources Board
Cupitt, Larry	ORD/NERL
Deschambault, Lynda	Region 9
Frank, Neil	OAR/OAQPS
KenKnight, Jeff	Region 10
Lorber, Matthew	ORD/NCEA
Mitchell, Kenneth	Region 4
Nazemi, Mike	South Coast Air Quality Management District
Nelson, William	Agency for Toxic Substances and Disease Registry
O'Neill, Francis	Region 6

Palma, Ted	OAR/OAQPS
Payne-Sturges, Devon	OA/OPEI
Poshyvanyk, Motria	Region 5
Robinson, Randy	Region 5
Shapiro, Paul	ORD/NCER
Sivak, Michael	Region 2
Smuts, Marybeth	Region 1
Touma, Joe	OAR/OAQPS
Victery, Winona	Region 9

Group # 2 (Blue)

Attendees:

Bortnick, Steve	Battelle Memorial Institute
Braye, Stacy	Region 9
Chalmers, Ray	Region 3
Coggiola, Michael	SRI International
Daye, Richard	Region 7
Diehl, Kathy	Region 9
Fegley, Robert	ORD/OSP
France, Danny	Region 4
Girman, John	OAR/ORIA
Hutzell, Bill	ORD/NERL
Kotchenruther, Robert	Region 10
Lessler, Richard	Region 9
Luecken, Deborah	ORD/NERL
Maresh, Nancy	Maresh Brains at Work

Murchison, Linda	California Air Resources Board
Nguyen, Phuong	Region 5
Overstreet, Cheryl	Region 6
Sheldon, Linda	ORD/NERL
Sieffert, Margaret	Region 5
Tax, Wienke	Region 9
Topper, Henry	OPPTS/OPPT
VanArsdale, Alan	Region 1
Wilson, Patrick	Region 9

Group # 3 (Red)

Attendees:

Bailey, Chad	OAR/OTAQ
Bellizzi, Carol	Region 2
Bohnenkamp, Carol	Region 9
Boyes, William	ORD/NHEERL
Broadbent, Jack	Region 9
Brown, David	NESCAUM/EHHI
Chung, Kuenja	Region 6
Dugre, Sylvia	Region 9
Graham, Stephen	ORD/NERL
Guinnup, David	OAR/OAQPS
Hildemann, Lynn	Stanford University
Isakov, Vlad	California Air Resources Board
Levy, Libby	Region 9
Madrone, Brook	Region 10

Norris, Gary	ORD/NERL
Sax, Todd	California Air Resources Board
Stetzer, Shannon	Battelle Memorial Institute
Tool O'Neil, Barbara	Region 9
Wapensky, Lawrence	Region 8
Watkins, Tim	ORD/NERL
Whitaker, Don	ORD/NERL
Wood, Periann	Region 9

Group # 4 (Green)

Attendees:

Adgate, John	University of Minnesota
Antley, Beth	Region 4
Bandrowski, Mike	Region 9
Bohning, Scott	Region 9
Brock, John	Region 9
Burke, Janet	ORD/NERL
Chun, Alvin	Region 9
Driscoll, Barbara	OAR/OAQPS
Ellsworth, Todd	Region 3
Hiatt, Gerald	Region 9
Kahn, Peter	Region 1
Klauder, David	ORD/OSP
Morin, Barbara	Rhode Island Dept. of Environmental Mngt.
Murchie, Peter	OAR/OAQPS
Owen, Coe	Region 9

Ozkaynak, Haluk	ORD/NERL
Rose, Keith	Region 10
Waldman, Jed	California Department of Health Services
Woodlee, Jeff	Region 9

Breakout Session II: Discussion of Modeling Questions (Day 2)

Goals / Objectives:

- Discuss Modeling Questions – Potential Topics:
  * How active are the Regions in ambient air modeling?
  * What types of assessments are being done?
  * What are the priorities? What is important?
  * Where do the Regions want to be with ambient air toxics modeling and skills?
  * What obstacles exist? What do the Regions need? Guidance? Tools? Etc.
  * What is needed to overcome these obstacles?
  * Suggested workshop follow-up items.

Report Out from Breakout Groups

Region 2 - 'squeaky wheels'

NATA - how to use: highlights air toxics

- use/focus on non-road issues
- NATA at large scale - useful
- weak agency support - "an embarrassment"

Air Modeling

Region 10

1. Idaho, grid (Boise): assessment: building emissions inventory
2. Region wide
   - exposure (Portland & Seattle)
   - goal - develop inventory
   - also using grid system
   - ARB to supply photochemical modeling
   - Seasonal: estimate annual average
   - to use as background concentration
   - especially for reactive VOCs
   - 4 x 4 km: Statewide
   - air basins

- local scale - SAC, LA, BA (maybe)
- OTAQ - mobile sources important to NATA
  - improving inventories
  - where is exposure? -> near/on roadways
  - Oregon/Washington DEP $
  - linked-based inventories
  - travel counts/demand
  - travel planning systems

Needs

- RIO - FTE $
- Guidance for use of models: which to use? what does it entail?
- use it uniformly
- Two or Three NAAQS standards to work with
- concentration - related
- numbers to work toward - target
- How will we support work in Air Toxics and enhance Air Toxics reporting requirements
- Need local inventories to support local models and local process, to get it and be able to use it
- Reporting Rule - uniform reporting; "CERR" for Air Toxics
- Report locations and release parameters

Problem

- Not doing more for Air Toxics
  - Use central technology to get BEST reduction
  - treat HAPs similar to criteria pollutants
  - look at reactivity and toxicity
- Accelerate mobile source air toxics rule application and new rules
- Are Air Toxics a Priority?

Group # 1 (Yellow)

Attendees:

Bandrowski, Mike	Region 9
Bellizzi, Carol	Region 2
Bortnick, Steven	Battelle Memorial Institute
Brown, David	NESCAUM/EHHI
Dugre, Sylvia	Region 9
Hiatt, Gerald	Region 9
Isakov, Vlad	California Air Resources Board
KenKnight, Jeff	Region 10
Maresh, Nancy	Maresh Brains at Work
Morin, Barbara	Rhode Island Dept. of Environmental Mngt.
Murchie, Peter	OAR/OAQPS
Norris, Gary	ORD/NERL
O'Neill, Francis	Region 6
Ozkaynak, Haluk	ORD/NERL
Palma, Ted	OAR/OAQPS
Shapiro, Paul	ORD/NCER
Touma, Joe	OAR/OAQPS
Tsai, Pam	Region 9
Whitaker, Don	ORD/NERL
Woodlee, Jeff	Region 9

Group # 2 (Blue)

Attendees:

Blair, Judith	Maresh Brains at Work
Bohning, Scott	Region 9
Boyes, William	ORD/NHEERL
Braye, Stacy	Region 9
Burke, Janet	ORD/NERL
Coggiola, Michael	SRI International
Diehl, Kathy	Region 9
France, Danny	Region 4
Hildemann, Lynn	Stanford University
Kahn, Peter	Region 1
Levy, Libby	Region 9
Luecken, Deborah	ORD/NERL
Madrone, Brook	Region 10
Mitchell, Kenneth	Region 4
Owen, Coe	Region 9
Poshyvanyk, Motria	Region 5
Robinson, Randy	Region 5
Rose, Keith	Region 10
Sheldon, Linda	ORD/NERL
Smuts, MaryBeth	Region 1
Topper, Henry	OPPTS/OPPT
Wapensky, Lawrence	Region 8
Watkins, Tim	ORD/NERL
Wood, Periann	Region 9

Group # 3 (Red)

Attendees:

Bailey, Chad	OAR/OTAQ
Bohnenkamp, Carol	Region 9
Brock, John	Region 9
Brown, Catherine	Region 9
Chalmers, Ray	Region 3
Chung, Kuenja	Region 6
Cook, Jeff	California Air Resource Board
Cupitt, Larry	ORD/NERL
Ellsworth, Todd	Region 3
Fegley, Robert	ORD/OSP
Graham, Stephen	ORD/NERL
Kotchenruther, Robert	Region 10
Lessler, Richard	Region 9
Murchison, Linda	California Air Resources Board
Nazemi, Mike	South Coast Air Quality Mgt. District
Nguyen, Phuong	Region 5
Payne-Sturges, Devon	OA/OPEI
Stetzer, Shannon	Battelle Memorial Institute
Tax, Wienke	Region 9
Toole O'Neil, Barbara	Region 9

Group # 4 (Green)

Attendees:

Adgate, John	University of Minnesota
Antley, Beth	Region 4
Baugh, Thomas	Region 4
Broadbent, Jack	Region 9
Chun, Alvin	Region 9
Daye, Richard	Region 7
Deschambault, Lynda	Region 9
Driscoll, Barbara	OAR/OAQPS
Frank., Neil	OAR/OAQPS
Girman, John	OAR/ORIA
Guinnup, David	OAR/OAQPS
Hutzell, Bill	ORD/NERL
Klauder, David	ORD/OSP
Lorber, Matthew	ORD/NCEA
Nelson, William	Agency for Toxic Substances and Disease Registry
Overstreet, Cheryl	Region 6
Sax, Todd	California Air Resources Board
Sieffert, Margaret	Region 5
Sivak, Michael	Region 2
VanArsdale, Alan	Region 1
Victery, Winona	Region 9
Waldman, Jed	California Dept. of Health Services
Wilson, Patrick	Region 9

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX E: PARTICIPANT EVALUATION SUMMARY

Meeting participants agreed that the information they gained from the workshop would help them perform their job better, especially topics on exposure assessment, monitoring, and modeling. Some attendees felt that topics concerning risk modeling and source apportionment were not very useful to them. Though it was agreed that the presentations were effective in communicating regional issues and ORD science to address those issues, the majority of participants felt that the workshop should have contained more regional air toxics exposure assessment issues, and some would have liked to see more emphasis on risk communication.

Participants agreed that the presentations were sufficiently tailored to suit their information needs. Meeting attendees were split regarding whether breakout sessions were effective in providing an opportunity to further explore the topics using the information learned. Some felt that breakout groups should have been smaller to allow for more interaction. In addition, about half of the meeting attendees felt that there was not enough time allotted to breakout sessions, though the other half felt that ample time was allotted. Many participants agreed that an interactive meeting format was favorable and should be more frequently utilized in future workshops. Overall, participants agreed that the meeting was useful and successful, and consistently offered positive feedback and praise to the organizers for a great workshop.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX F: AIR TOXICS CASE STUDIES

Mini-Case Studies of Air Toxics Monitoring and Modeling

This is a compendium of mini-case studies of air toxics monitoring and modeling projects at different scales and in different locations. It is meant to provide some sense of the range of monitoring and modeling approaches that has been used and contacts where you can get more information on specific projects of interest. We hope that people will add suggestions for projects that could be written up and added to this group and even provide write-ups in the format that is being used. The more case studies there are, the richer the resource will be.

Questions, suggestions, and contributions can be addressed to the following:

Ken Mitchell
USEPA/Region 4/APTMD
Tel: 404-562-9046
Email: mitchell.ken@epa.gov

Ted Palma
USEPA/OAQPS/ESD/REAG (C404-01)
Tel: 919-541-5470
Fax: 919-541-0840
Email: palma.ted@epa.gov

Paul Shapiro
USEPA/ORD/NCER (8722R)
Tel: 202-564-6833
Fax: 202-564-2447
Email: shapiro.paul@epa.gov

CONTENTS

1. Atsugi, Japan

The Shinkampo Incinerator in Atsugi Japan Case Study

I. Project Name and Location, Project Sponsor, Brief Overview

The United States Naval Air Facility at Atsugi, Japan (NAF Atsugi) is located in the Kanto Plain area on the island of Honshu, Japan. Directly to the south of the facility, in the Tade River Valley, was the Shinkampo Incinerator Complex (SIC). The Incinerator is no longer in operation, having closed in May of 2001. While operating, three incinerators were licensed by Japan to burn general industrial waste and infectious industrial waste (medical), and were incinerating up to 90 tons a day. The pollution control devices included precipitators and scrubbers. The 4-5 acre facility was located in a small river valley, and the NAF Atsugi is positioned on a plateau at the end of the valley. While the incinerator stacks were about 25 m high from the valley base, they were only about 15 m higher than the ground level of the NAF Atsugi. Further, these stacks were only 250 m away from the nearest high-rise housing unit and about 1000 m from a school and day care center. The predominant wind direction is from south to north during the spring and summer; conversely from north to south during the fall and winter. When blowing from south to north, the plume moves directly onto the base where exposures could occur. The NAF Atsugi was not permitted to test the stacks, and was not provided with stack test information by the owners of the facility. Subsequently, their evaluation of environmental impacts focused on environmental monitoring on NAF Atsugi, including extensive air and soil testing programs. Numerous organic and inorganic contaminants were measured in these programs. Also, the Navy conducted additional analyses to understand the origin of what they were measuring. Specifically, wind speed and direction measurements were taken along with all air monitoring data, as well as observational data regarding the incinerator operation (operating/shut down, color of smoke in plume, etc.). Interestingly, they found that only a handful of the measured contaminants could be unambiguously attributed to the incinerator, including dioxins, PM_{10}, hydrochloric acid, lead, cadmium, and arsenic. Some important risk driving contaminants, such as benzene, showed much less correlation with wind direction suggesting other on-base sources, such as the regular deployment of the airplanes as part of the airbase operations. To further enhance their understanding of exposure and incinerator emissions, they also conducted air dispersion modeling using ISC3. Using the network of air measurements and the wind speed data, they calibrated the ISC3 on several contaminants including dioxin to be able to estimate on stack emission rates, and to develop a refined concentration term for human exposure assessment. Interestingly, dioxin emissions were estimated to total 18 g TEQ/yr, which is not particularly high for incinerators, although air concentrations are some of the highest regularly measured in the world. This was because of the low height of the stack and the proximity to exposure locations.

The National Center for Environmental Assessment (NCEA)/ORD was enlisted to support the Navy in their efforts at this site in 1997, mostly in their interpretation of dioxin air data, design of a dioxin soil testing program, and assessing risk due to dioxin exposure. The Navy is expected to finalize its comprehensive risk assessment on this site during 2002, and to then make publicly available its extensive wealth of monitoring data and modeling studies.

II. Contact name and Information

Matthew Lorber

National Center for Environmental Assessment (8623D)

US EPA

1200 Pennsylvania Ave, NW

Washington, DC 20460

ph: 202 564-3243

email: lorber.matthew@epa.gov

III. Uses of Modeling and Monitoring

This is a unique example where modeling was only used to supplement an extensive monitoring program. In many circumstances such as this one, stack test information is combined with modeling to understand exposure. Because of the cost and other factors such as uncertainty (enough samples? downwind conditions?, and so on), monitoring is usually not relied upon for exposure assessing and most often just used to verify, or "truth test" results of modeling. In this case, however, literally millions of dollars were spent determining exposure point concentrations for exposure and risk assessing.

IV. Key Results

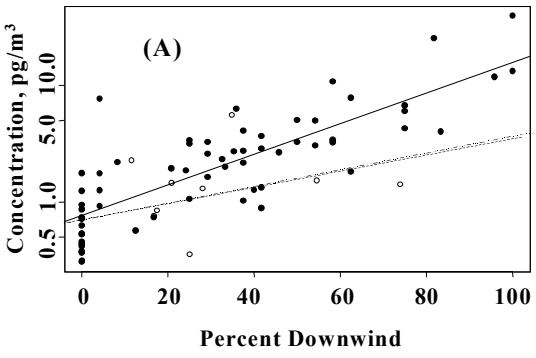
Two abstracts containing dioxin air and soil data have been submitted to the Dioxin 2002 conference, to be held in August of 2002. NAF Atsugi contractor reports have additional information.

Figures showing percent of time wind was blowing from the incinerator to the air monitor, clearly showing the impact of the incinerator ---->

Table 1. Summary of TEQ results for the categories of soil samples.

Description	n	TEQ, pg/g	TEQ range
Exposure Study Areas	28	15	<1 - 90
Reference Study Areas	12	27	13 - 62
Trend - downwind and impacted	11	266	66 - 642
Trend - all other samples	22	14	8 - 83

Descriptions: "Exposure Study Areas" - locations such as schools, apartment buildings where exposure could occur; "Reference Study Areas" - remote sites on NAF Atsugi where only deposition would likely have caused soil elevations, if any; "Trend - Downwind & Impacted" - all trend samples were randomly spaced in a study design to evaluate trends. The downwind & impacted samples were a cluster of 11 samples all downwind and near, within 300 meters, to the incinerator. The other 22 trend samples were spaced up to a kilometer away from the incinerator.



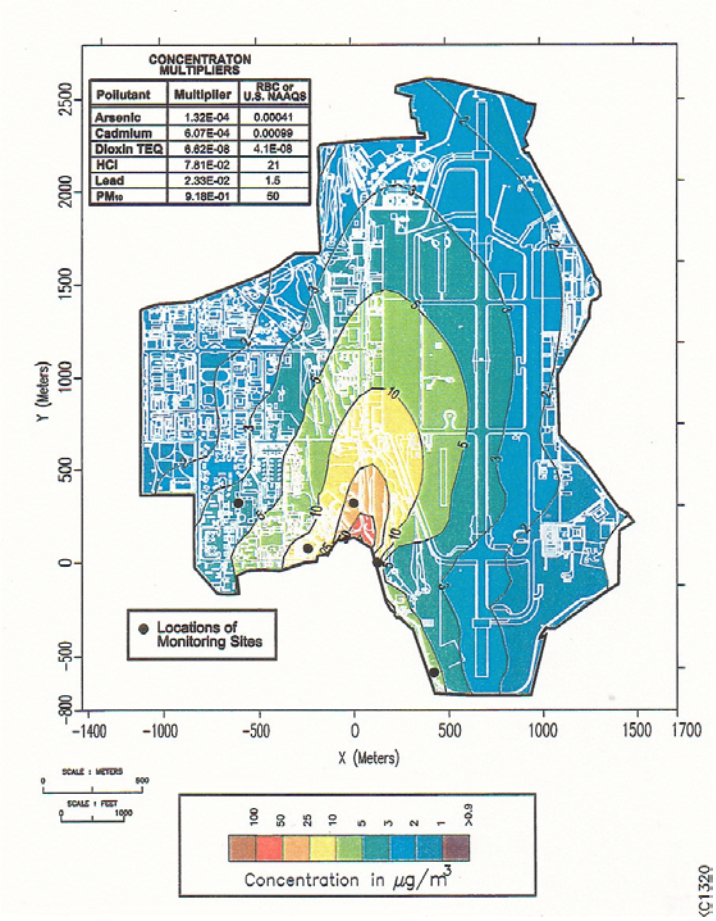


Figure showing the results of the air monitoring exercise, for the 6 contaminants unambiguously originating from the incinerator. The concentrations are modeled concentrations per g/sec unit emissions. These measurements get multiplied by the "multiplier" identified to get predicted air measurements.

VI. Lessons Learned

The fact that stack monitoring was not allowed made this a unique circumstance where ambient air monitoring, wind speed/direction monitoring, and modeling were used to understand exposure to this source. The air monitoring was extremely expensive, but may have been uninformative had not wind speed and direction measurements accompanied all air concentration measurements. Certainly in every similar circumstance, all efforts must be made to conduct stack sampling to understand what is being emitted from the source.

2. Columbus, OH

Columbus Municipal Solid Waste Incinerator Case Study

I. Project Name and Location, Project Sponsor, Brief Overview

In 1992, a stack test revealed that the Columbus Municipal Solid Waste-to-Energy Incinerator (WTE) was emitting at a rate equal to about 1000 grams of dioxin toxic equivalents (TEQs) per year. To put this in perspective, EPA's Dioxin Sources Inventory estimated that all known and quantified sources were emitting about 12,000 g TEQ/yr in 1987 and 3,000 g TEQ/yr in 1995. As a result of this alarming stack test, Region 5 began developing the scientific basis for an Emergency Order to require the owners of the Columbus WTE to install MACT controls well ahead of the federally-mandated schedule. The Region enlisted the National Center for Environmental Assessment (NCEA/ORD) to assist in the conduct of a risk assessment on the impacts of these dioxin emissions. This assessment entailed use of air modeling (using stack emission data) to simulate the arrival of dioxins at nearby farms, the routing of these dioxins through the food chain, and finally the estimation of exposure and risk to a farm family consuming home-grown foods. The Emergency Order was instated in 1994, and it required the owners of the Columbus WTE to install MACT by 1997. During 1994, owners of the Columbus WTE made some process changes (temperature of combustion, installation of quenches) in an attempt to reduce dioxin emissions. To evaluate the effectiveness of these procedures, additional stack tests and ambient air monitoring were conducted by the State of Ohio EPA in the spring and summer of 1994. In December of 1994, the Columbus WTE shut down, citing lack of funding to maintain operations, much less comply with the Emergency Order to install MACT. In 1995, the Region enlisted the support of NCEA in the design of a soil monitoring study to understand the potential long-term impacts of dioxin emissions. NCEA has continued to use this wealth of data to study the relationships between dioxin emissions and environmental impacts. One evaluation focused on the relationships between all the media which had been sampled, including stack emissions, incinerator ash, air, and soil. A second evaluation used the stack emission, air, and soil data in model validation/calibration exercise. This exercise involved use of the ISC3 model, to see how well it would predict measured dioxin air concentrations, and then it used predicted deposition rates in a soil concentration model to see how well predicted soil dioxin concentrations would match measured concentrations.

II. Contact name and Information

Matthew Lorber
National Center for Environmental Assessment (8623D)
US EPA
1200 Pennsylvania Ave, NW
Washington, DC 20460
ph: 202 564-3243
email: lorber.matthew@epa.gov

III. Uses of Modeling and Monitoring

This case study represents a comprehensive example of the interplay between modeling and monitoring, and even more, how these exercises and evaluations play into the regulatory decision-making process at EPA. Such efforts are possible, and maybe uniquely possible, with the suite of compounds generally called "dioxin-like compounds" or just "dioxins", for these reasons: 1) dioxins are one of the most toxic chemicals ever produced by man, and as such, one of the best studied class of compounds for human health effects, environmental fate, human exposure, source characterization, and other disciplines, 2) dioxins are persistent in the environment, including in air, soils, and sediments, and they bioaccumulate in terrestrial and aquatic animals. This increases the likelihood of success for just about any monitoring program. 3) these same tendencies for persistence and bioaccumulation also make dioxin the ideal class of compounds to model. The models are being used to predict long-term trends, which tends to be an easier chore than asking them to predict short term events.

IV. Key Results

The results from the Columbus WTE studies by NCEA are covered in three publications. These publications and a sample of some of the results are:

1. Lorber, M.; Cleverly, D.; Schaum, J. 1996. A screening level risk assessment of the indirect impacts from the Columbus waste to energy facility in Columbus, Ohio. Proceedings of an International Specialty Conference, sponsored by the Air and Waste Management Association and the United States Environmental Protection Agency, held April 18-21, 1996 in Washington, D.C. published in, Solid Waste Management: Thermal Treatment & Waste-to-Energy Technologies, VIP - 53. pp. 262-278. Air & Waste Management Association, One Gateway Center, Third Floor, Pittsburgh, PA 15222.

Exposure and risk results for the Columbus WTE risk assessment.

Exposure Pathway	Lifetime Average Daily Dose ng TEQ/kg-day	Excess Cancer Risk
Soil Dermal Contact	$6*10^{-8}$	$9*10^{-9}$
Vegetable Ingestion	$1*10^{-5}$	$2*10^{-6}$
Inhalation	$6*10^{-6}$	$9*10^{-7}$
Beef Ingestion	$1*10^{-3}$	$2*10^{-4}$
Milk Ingestion	$5*10^{-4}$	$8*10^{-5}$

2. Lorber, M, P. Pinsky, P. Gehring, C. Braverman, D. Winters, W. Sovocool. 1998. Relationships between dioxins in soil, air, ash, and emissions from a municipal solid waste incinerator emitting large amounts of dioxins. Chemosphere, Volume 37:2173-2197.

Result: Isolines of equal soil TEQ concentration around the Columbus WTE location.

3. Lorber, M., A. Eschenroeder, R. Robinson. 2000. Testing EPA's ISCST-Version 3 Model on Dioxins: A comparison of predicted and observed air and soil concentrations. Atmospheric Environment 34:3995-4010.

Results: Isolines of predicted air concentrations compared against measured air concentrations of TEQ for one sampling date in March, 1994.

VI. Lessons Learned

If encountering a similar situation - an incinerator emitting large amounts of dioxin-like compounds - here are some of the things we can do differently and better to understand and remedy the situation:

1) More air sampling within 1 km while incinerator is operating to better understand the plume.
2) Search for more exposure matrices to sample, such as impacted farm animals (cows, free range chickens).
3) If the incinerator has been operating long enough, consider identifying and sampling blood of a potentially exposed population along with a control population.
4) Further study the environmental transformations of specific dioxin-like compounds from source to environmental matrix (soil particularly).

3. Kenova, KY, WV, OH

Tri-State Geographic Initiative Case Study

I. Project Name and Location, Project Sponsor, Brief Overview

Tri-State Geographic Initiative

- Located along the Big Sandy and Ohio Rivers at the convergence of Kentucky, West Virginia, and Ohio
- Sponsored by:

  Ohio Environmental Protection Agency

  West Virginia Division of Environmental Protection

  Kentucky Department for Environmental Protection

  U.S. Environmental Protection Agency Regions 3, 4, and 5

II. Contact Name and Information

Ken Mitchell
Chief, Air Toxics Assessment and Implementation Section
U.S. Environmental Protection Agency, Region 4
404-562-9065
mitchell.ken@epa.gov

III. Key Questions Addressed and Purpose of the Project

In 1991, Kentucky, West Virginia, Ohio, and the United States Environmental Protection Agency partnered to study environmental problems in the highly industrialized area where the three states meet. This project came to be known as the **Tri-State Geographic Initiative or TGI.** Public concern, and the availability of time, resources, and data led the partners to focus on the impact of air, drinking water, and fish consumption on human health in the area.

This case study will focus on air quality which emerged as a priority in the study. The TGI technical steering committee established the Air Toxics Project through which air monitoring,

dispersion modeling, and assessment of risks associated with these air pollutants was carried out. The results of these analyses will help set priorities for improving environmental quality and public health in the area.

Resource constraints made it impossible to study the entire 2300 square mile area concurrently, so the major sources of air pollution in the area were grouped into six clusters which could be studied individually. One of these clusters consisted of several industrial sources in the Kenova, West Virginia area. The Kenova cluster study area straddles the banks of the Big Sandy River, and includes not only industrial complexes (including a refinery), but also residences, schools, day care, and other commercial concerns.

IV. Uses of Modeling and Monitoring

Air monitoring and modeling were conducted for the July 1996 to July 1997 period.

- Monitoring:
  - < 7 fixed sites sampled every 12-14 days for volatile organic chemicals, semi-volatile organic analytes, metals, and acid/base gases to assess chronic human health concerns. A triggered sampler was located at one of the fixed locations to collect VOC samples when concentrations were elevated.
  - < A mobile laboratory collected continuous VOC samples over 15 weeks at 4 locations to assess acute risks

- Modeling
  - < Area specific meteorological data were collected
  - < Air quality effects were modeled based on reported releases from four major chemical facilities in the Kenova area using four scenarios:
    - T Daily meteorological data and highest reported emissions to represent a worst case scenario
    - T Daily meteorological data and daily emissions to represent a typical scenario
    - T Daily meteorological data and daily emissions during periods when episodes were known to have occurred
  - < Emissions from mobile sources and small businesses were not modeled

V. Key Results

- Long-term air monitoring
  - < Hazard indices exceeded 1 at all stationary sampling sites indicating an area-wide concern for non-cancer effects in humans with chromium being the primary contributor to the risk
  - < All sampling sites exceeded 1E-6 cancer risk, and all but one site were lower than 1E-4 cancer risk, with benzene and chromium driving the risk

- Modeled air risks
  - < Of the 4 facilities analyzed, only one had modeled emissions that resulted in risks above the levels set in the risk management plan(hazard index > 1, or cancer risk > E-6)

VI. Lessons Learned

- At air monitoring locations, risks predicted based on air monitoring results tended to be higher than risks estimated based on modeling results.
- Modeling indicates that highest modeled industrial source risks are near facility boundaries, and that risks are typically lower in residential areas further removed from the facilities.
- Modeling results are only as good as the data provided by the industries, some of which are supportive, and some of which may provide only typical or average data.
- Modeling can provide a better indication of daily values, since monitoring does not occur every day and may miss episodic emissions.
- Modeling allows the pinpointing of sources of particular chemicals; monitoring reports values that are a composite of emissions from many sources.
- Because relatively few such studies have been conducted, interpreting the results is difficult - Were these results typical or atypical nationally? Would a plant-specific, regional, or national policy be most appropriate to address the risks?

4. Los Angeles International Airport

I. Project Name and Location, Project Sponsor, Brief Overview

Los Angeles World Airports: Air Quality and Source Apportionment Study of the Area Surrounding Los Angeles International Airport:

Vol I. Technical Work plan, Vol. II. Quality Assurance Project Plan were prepared for LAWA using contractors from CDM and academic experts (John Watson, Desert Research Institute, and Ron Henry, University of Southern California), dated November 10, 2000. Both are draft pending external peer review funded by EPA to be completed in a peer review workshop expected to occur in July 2002. Winona Victery is the contact in Region 9; EPA is funding peer review; further implementation will require Federal funding (expected to be $470,000 for one-month pilot) and year-long study $2-3,000,000. LAWA unable to fund after 9/11.

II. Contact Names and Information

Sabrina Johnson, EPA, OAR, HQ, 202-564-1173, johnson.sabrina@epa.gov

Roger Johnson, LAWA, 310-646-9640, rjohnson@lawa.com

Joellen Lewtas, EPA, ORD, NERL, 206-553-1605, lewtas.joellen@epa.gov

Winona Victery, EPA, Region 9, 415-972-3736, victery.winona@epa.gov

III. Key Questions Addressed and Purpose of the Project

Los Angeles World Airports (LAWA) proposes to conduct an air quality study to develop detailed information about the role of the Los Angeles International Airport (LAX) in emitting air pollutants and the impact the emissions have in the neighborhoods around LAX. This is the first attempt at performing such a study near an airport.

IV. Uses of modeling and monitoring

Emissions data collected by both on-site and off-site monitoring and comprehensive characterization of emission sources and mass emissions with those sources for facilities. Source apportionment techniques will include chemical composition receptor modeling, spatial gradient analysis, time series analysis, emissions inventory development, and air dispersion modeling. Monitoring will be performed to identify source-dominated baseline site and neighborhood sites. Analytes include gases, particle mass and chemistry, substrate sampling, and meteorology.

Dispersion modeling will attempt to determine how much of each pollutant of concern in nearby neighborhoods is contributed by LAX relative to non-LAX emitters, what is the uncertainty of these source contributions? What are the dominant source categories that contribute to each pollutant of concern from LAX and non-LAX emitters? How do source contributions from different source types differ by time of day, day of week, and time of year?

V. Key Results

Study is on hold pending external peer review and availability of funds.

VI. Lessons Learned

LAWA contractor hired monitoring and modeling experts at the request of the LAX Technical Work Group to draft the technical work plan. EPA and State of California Air Resources Board, and South Coast Air Quality Management District, and FAA served on this workgroup. Work by the first group of LAWA staff was poor and the lead Camp Dresser McGee consultant was hired by the airport to replace the LAWA staff. LAWA agreed to accept EPA and California Air Resources Board recommendations for external authors. The Technical Work Group who had recommended the experts then had to wait for the re-draft of the original document. EPA, CARB and South Coast AQMD did not feel comfortable asking for peer-review of the LAWA-funded document. When LAWA funding was no longer available, the airport had already committed publicly about performing this study with EPA oversight, we agreed that external peer review was necessary and that EPA could fund that. LAWA has been hopeful that we can still perform the Air Quality and Source Apportionment Study.

5. Milwaukee, WI, and Sacramento, CA

I. Project Name and Location, Project Sponsor, Brief Overview

Testing of a Model to Predict Human Exposure to Aldehydes Arising from Mobile and Point Sources. EPA STAR Grant No. R 826787-01-0
J. H. Raymer*, G. Akland, T. Johnson, D. J. Smith, D. A. Whitaker, and T. Long

II. Contact Name and Information

James H. Raymer
RTI International
3040 Cornwallis Road, RTP, NC 27709

Telephone: (919) 541-5924
e-mail: jraymer@rti.org

III. Key Questions Addressed and Purpose of the Project.

The main hypothesis to be tested is that a mathematical model can be used to predict personal exposure distribution to aldehydes. Additional hypotheses to be tested are that (a) personal exposure levels of aldehydes exceed outdoor concentrations; (b) indoor aldehyde concentrations exceed outdoor concentrations; and (c) the composition of oxygenated fuel results in significant differences in population exposures to aldehydes.

IV. Uses of Modeling and Monitoring

Milwaukee, Wisconsin (because of the use of ethanol in the gasoline) and Sacramento, California (because of the use of methyl *t*-butyl ether or MTBE) were chosen for the field studies. These two field studies, conducted for approximately 40 days each during the summers of 1999 and 2000, were both directed towards acquiring representative personal monitoring data that will be used to estimate the exposures of urban and suburban residents to selected aldehydes, volatile organic compounds (VOCs), and carbon monoxide (CO). Aldehydes (formaldehyde, acetaldehyde, acrolein, propionaldehyde, butyraldehyde, crotonaldehyde, glyoxal, methylglyoxal) were sampled using DNPH silica cartridges, VOCs (ethanol, MTBE, benzene, toluene, xylenes) were sampled using sorbent tubes, and CO was measured using real-time monitors. Air exchange in each home was evaluated.

Through the collection and analysis of VOCs and CO in addition to the aldehydes, the design permits a source apportionment of the aldehyde contribution to exposure that originates from direct emissions from mobile sources, those which are photochemically produced from mobile source emissions, combustion processes, and contributions of other sources and environments

which also contribute to these exposures. Data from the Global Positioning System (GPS) were collected and evaluated as a means of participant tracking. Supplemental data were obtained from indoor and outdoor pollutant monitors at the residences of the volunteers, from ambient pollutant and meteorological monitors at fixed-site locations in each city, from real-time diaries completed by the technicians and volunteers, and from questionnaires completed by the volunteers. The field design was model-based, that is, the monitoring field data were gathered for input into the model or to test and validate modeled predictions. Measured and predicted exposures will be compared for determining uncertainties of the modeled exposures.

Each field study (city) had two components. In the first component (Phase A), integrated personal exposures for 38 and 33 volunteers, for Sacramento and Milwaukee, respectively, were measured once during a summer season. This study is similar in design to other personal exposure studies except that the volunteers will be randomly chosen according to selection criteria related to location of residence. The study population was selected according to spatial gradients away from the downtown area. Twenty four-hour measurements of the corresponding indoor and outdoor concentrations at the residence of each subject were also made. In the second component (Phase B, "scripted") the exposures of a technician to the same set of pollutants was measured as the technician followed a set of prepared instructions, called scripts, to follow throughout the day.

These scripts outlined the activities and microenvironments to which the technician will be exposed on a given day, e.g., commuting downtown, driving in street canyons, walking inside, walking outdoors around a commercial area away from a roadway. The script provided instructions to the technician specifying (1) the duration of an air sample to be taken during each sampling period, (2) the general and microenvironmental location during the sampling period, and (3) the general activities undertaken during the period. Personal exposure monitors (aldehyde-DNPH, VOCs, and CO) were used to measure 1-hr and 12-hr exposures to each compound as the technician simulated the activity patterns of typical city residents. Using the data generated from the scripted study and information about the activities of the study participants in the personal monitoring study, the 24-hour exposures of the participants will be predicted using an existing EPA model, pHAP, and compared to those measured.

V. Key Results

To date, all of the samples have been collected, analyzed, and assembled into a database that also contains the meta data. A series of stepwise linear regression (SLR) analyses were performed on these data to identify the factors that best predicted exposure to each pollutant. The aldehydes measured in Sacramento by microenvironment are shown in Figure 1. The highest concentrations of aldehydes were found indoors at a restaurant, indoors at a residence, transportation in a car, indoors at a grocery store, and outdoors within 10 yards of the roadway. The percent of the variability for formaldehyde and acetaldehyde explained by the microenvironment is shown in Table 1. Much higher total correlations were observed for formaldehyde.

For comparison, the aldehyde concentrations measured in various microenvironments in Milwaukee are shown in Figure 2. The highest aldehyde median concentrations were found indoors at a store, indoors at a restaurant, and indoors at the technician's residence. Analogous SLR analyses have not yet been performed for Milwaukee. This information will be of use to the U.S. EPA in determining the significance of microenvironment on human exposure.

VI. Lessons Learned

Indoor exposures to formaldehyde and acetaldehyde are higher than outdoor exposures, especially in areas with food and food preparation.

Further lessons await completion of the data analysis.

Figure 1. Sacramento Study Aldehyde Results. (n = number of total observations; IND = indoors, OUT = outdoors; c.f. Table 1)

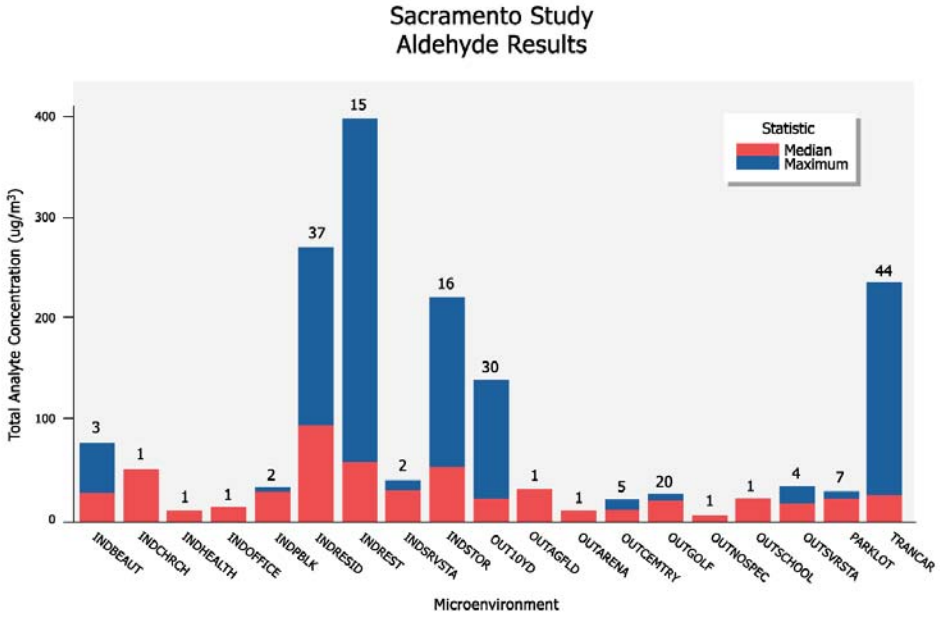


Table 2. Results of Stepwise Linear Regression Analyses Performed on Formaldehyde and Acetaldehyde Concentrations - Sacramento Scripted Activity Study

Compound	Binary Predictor Variable	Regression Coefficient	Cumulative R^2 Value
Formaldehyde	Constant	7.5	0.000
(n = 191)	Indoors - store	12.4	0.172
	Indoors - residence	13.0	0.354
	Indoors - auto parts store	29.8	0.433
	Indoors - restaurant	10.8	0.500
	Using solvents	34.5	0.558
	Smoke from forest fires	29.5	0.601
	Indoors - church	17.5	0.616
	Indoors - service station	11.5	0.629
	Indoors - furniture store	16.1	0.638
	Indoors - building supply store	10.0	0.650
Acetaldehyde	Constant	13.9	0.000
(n = 192)	Air conditioning on	26.0	0.238
	Drinking alcoholic beverage	25.1	0.292
	Indoors - grocery store	92.1	0.331
	Indoors - residence	22.6	0.360
	Eating	20.3	0.378

6. Minneapolis-St. Paul, MN

I. Project Name and Location, Project Sponsor, Brief Overview

A Comparison of Community, Residential, and Personal Exposure in Minneapolis-St. Paul, Minnesota
EPA STAR Grants R825241 and R827928

II. Contact name and Information

Gregory Pratt
Minnesota Pollution Control Agency
520 Lafayette Rd
St. Paul, Minnesota 55155
651.296.7664
gregory.pratt@pca.state.mn.us

John L. Adgate
Univ. of MN School of Public Health
Div. of Environ. and Occup. Health
MMC 807
420 Delaware St SE
Minneapolis, MN 55455
612.624.2601
jadgate@umn.edu

III. Key Questions Addressed and Purpose of the Project

The purpose of this research was to estimate outdoor air concentrations of VOCs in the Minneapolis-St. Paul metropolitan area and compare them with outdoor, indoor, and personal monitoring. Based on preliminary modeling three neighborhoods were chosen for outdoor ambient, indoor, and personal monitoring. The modeled outdoor concentrations were then compared with the monitored outdoor concentrations to try to understand the reasons for agreement or lack of agreement. The modeling was done using the most commonly used EPA regulatory air dispersion model, ISCST3 (Industrial Source Complex Short Term version 3) and VOCs emission estimates from point, area, and mobile sources (mobile and area sources using 1997 and point using 1999 emission inventories). The point sources were modeled as point sources, and the area and mobile sources were resolved to the census tract level and modeled as area sources.

IV. Uses of Modeling and Monitoring

Only outdoor air VOC concentrations were modeled. Modeled concentrations were used to assist in selecting neighborhoods for outdoor, indoor, and personal monitoring. Three communities were selected: two (East St. Paul and Phillips) with relatively high and one (Battle Creek) with relatively low estimated ambient concentrations. Model estimates can be compared with outdoor measurements (matched in space and time) to provide information on model accuracy.

The monitoring data consisted of personal, indoor, and outdoor measurements of VOCs. The personal, indoor, and some outdoor measurements were made with personal organic vapor monitors (OVMs). Other outdoor measurements were made with sampling canisters analyzed by

GC-MS (the Federal Reference Method). There were 75 non-smoking study participants from three neighborhoods in the metropolitan area, each of whom had indoor (stationary residential) and personal measurements up to six times over three seasons. The monitoring data can be used to understand the relationships between indoor, outdoor, and personal VOC measurements. The data can also be used to look at the variability in indoor and personal measurements for a given home or person over time (i.e., longitudinal variability).

V. Key results

1. The OVM monitoring badges were an effective and relatively inexpensive method for obtaining 48 hour average VOC measurements for ~12 compounds;
2. OVMs compared well with canisters for most VOCs in this study;
3. Generally for measured VOCs: Personal > Indoor > Outdoor;
4. Air dispersion modeling with ISCST reasonably predicted outdoor VOC concentrations if the emission inventory was accurate;
5. The model tended to predict average concentrations and was less accurate at high or low concentrations. This is expected since the emissions inventory cannot capture the details of all of the temporal and spatial variability in emissions;
6. The ISCST model performed best in Battle Creek (relatively simple emissions scenario) and worst in Phillips (more nearby and relatively complex emissions);
7. The model failed to predict the higher VOC concentrations found in indoor and personal air.

VI. Lessons Learned

Modeling can be effective in predicting outdoor concentrations of VOCs. The most critical model input is the emissions inventory—without an accurate inventory the model predictions are not reliable.

An indoor air model and a personal exposure model would be necessary to estimate indoor air concentrations and personal exposures more accurately. Indoor air modeling requires an accurate inventory of indoor air pollution sources, and personal exposure modeling requires an accurate assessment of each microenvironment encountered by the study subject as well as a record of the amount of time spent in that microenvironment. We collected time-activity information on these subjects, but have limited data on sources in these homes and no air exchange data for these households. We also do not have data on air concentrations in microenvironments outside the home.

The outdoor air modeling presented in this case study is regulatory state of the art. It would be possible to use a more refined model, but the accuracy of the emissions data does not warrant that level of sophistication at this time.

7. National Air Toxics Assessment (NATA)

I. Project Name and Location, Project Sponsor, Brief Overview

National Air Toxic Assessment - Initial National Scale Assessment

II. Contact name and Information

Dave Guinnup, USEPA OAQPS, ESD/REAG (C404-01)
Research Triangle Park, NC 27711; 919-541-5368; guinnup.dave@epa.gov

III. Key Questions Addressed and Purpose of the Project

The National-Scale Air Toxics Assessment, which is based on 1996 emissions data, produced results that are useful in understanding the quality of air and its possible effect on human health nationwide. The assessment looked at 33 air pollutants (a subset of 32 air toxics from the Clean Air Act's list of 188 air toxics plus diesel particulate matter). The primary goal of the national-scale assessment was to identify those air toxics which are of greatest potential concern, in terms of contribution to population risk. The results will be used to set priorities for the collection of additional air toxics data (e.g., emissions data and ambient monitoring data).

IV. Uses of Modeling and Monitoring

The initial national-scale assessment is comprised of four major technical components: 1) compiling a national emissions inventory of air toxic and diesel PM for the year 1996 from outdoor sources; 2) estimating 1996 air toxics and diesel PM ambient concentrations; 3) estimating 1996 population exposures; 4) characterizing potential public health risks.

The 1996 National Toxics Inventory (NTI) is the underlying basis for the 1996 emissions used in the national-scale assessment. The NTI contains air toxics emission estimates for four overarching source types: major, area and other, onroad mobile, and nonroad mobile.

To develop nationwide estimates of annual average ambient concentrations of air toxics, EPA used the Assessment System for Population Exposure Nationwide (ASPEN) model (developed and used in EPA's Cumulative Exposure Project). The modeling domain for the national modeling effort is the contiguous United States, Puerto Rico and the Virgin Islands. The ASPEN model, which is based on the ISCLT2 dispersion model, estimates annual average ambient concentration of each air toxic pollutant at the centroid of each census tract within the geographic domain. In an effort to apply a "reality check" on the ASPEN estimates, results were compared to available ambient air monitoring data. EPA selected a representative subset of seven air toxics (benzene, perchloroethylene, formaldehyde, acetaldehyde, cadmium, chromium, and lead) mainly because these air toxics have the largest number of monitoring sites. In general the ASPEN model was found to underpredict impacts for most components.

The HAPEM4 model was used to predict the nationwide inhalation exposures. Through a series of calculation routines, the model makes use of census data, human activity patterns, ambient air quality levels, climate data, and indoor/outdoor concentration relationships to estimate an expected range of "apparent" inhalation exposure concentrations for populations of concern. The final step in the assessment include characterizing both cancer and noncancer effects on public health due to inhalation of study air toxics.

V. Key Results

The assessment developed a list of national priority air toxics. The pollutants that are predicted to have the greatest impact upon the largest number of people include: Benzene, Chromium, Formaldehyde, Acrolein. In general results of the assessment will be used to: identify air toxics of greatest potential concern; set priorities for collection of additional air toxics data at the EPA, state, local, and tribal level; roughly characterize the relative contributions to air toxics concentrations and population exposures of different types of air toxics emissions sources (e.g., mobile, large industrial, smaller industrial); establish a baseline for tracking trends over time in modeled ambient concentrations of air toxics; and establish a baseline to measure progress toward meeting goals for reductions of inhalation risk from ambient air toxics.

VI. Lessons Learned

A detailed peer review of the assessment by the SAB identified both the scientific strengths and weakness of the assessment. One possible lesson learned involved communicating the results of the assessment and assuring that these results are not misused. It is important that limitations and uncertainty on the data be defined and presented along with the results to prevent misuse or overuse of the study results.

8. Portland, OR

I. Project Name and Location, Project Sponsor, Brief Overview

Portland Air Toxics Assessment (PATA); Portland, OR (Multnomah, Clackamas and Washington counties); Oregon DEQ, METRO, USEPA (OTAQ and OAQPS)

II. Contact Name and Information

Peter Murchie
Policy, Planning and Standards Group
OAQPS/ESD
tel: 503-326-6554
murchie.peter@epa.gov

Arlene Rosenbaum and Ed Carr, ICF Consulting

III. Key Questions Addressed and Purpose of the Project

Project will help Oregon develop and implement risk/geographic-based air toxics program/rules. Goal is to have modeled and monitored data with risk characterization to help identify and prioritize risk reduction strategies.

IV. Uses of Modeling and Monitoring

Five urban monitoring sites in place from 1999 - 2001; refined stationary and mobile (emissions allocated to major roads) inventories for 1999 will be used to run CALPUFF; HAPEM5 will be run with ambient results; CALPUFF outputs will be compared with monitoring data to validate model. Modeled and monitored ambient data and risk characterization will be used to compare to the National Scale Assessment.

V. Key results

Monitoring information and 1996 National Scale Assessment results were used to identify pollutant drivers for project scoping. Plan to have modeled and monitored data and comparison with monitored values to be completed by September 30, 2002.

9. Port Neches, TX, Calcasieu, LA, and Little Rock, AK

Air Toxics Local Scale Assessment Case Studies

I. Project Name and Location, Project Sponsor, Brief Overview

Project name: Regional Air Impact Modeling Initiative: Pilot Studies - Initial Phase

Locations: Port Neches, Texas
Calcasieu, Louisiana
Little Rock, Arkansas

Project Sponsor: U.S. EPA Region 6

II. Contact Name and Information

Contact name: Jeff Yurk

Institution: U.S. EPA Region 6

Address: U.S. EPA Region 6
1445 Ross Ave
Mail code 6PD-O
Dallas, TX 75202

Phone number: 214-665-8309

E-mail address: yurk.jeffrey@epa.gov

III. Key Questions Addressed and Purpose of the Project

The U.S. Environmental Protection Agency (EPA), Region 6, has established a regional air impact modeling initiative (RAIMI) pilot program for estimating the combined health risks to individual receptors within a neighborhood as a result of aggregate exposure to multiple contaminants from multiple sources and multiple exposure pathways. The initial phase includes the estimation of potential aggregate inhalation risks associated with modeled air concentrations from significant local emission sources within the Port Neches Assessment Area, Jefferson County, Texas.

The overall strategy for completing the RAIMI pilot study was conceived to efficiently maximize the usefulness of existing guidance, risk assessment tools, and databases to suffice the following project design goals:

- Useful as a permitting tool to support EPA, state, and local permitting authorities – independently or combined – evaluate and demonstrate protectiveness of cross program permitting decisions and support holistic, tailored permit strategies with the flexibility to be either area (i.e., industrial complex), facility, or source-specific;

- Provide a standardized and consistent means by which all permitting authorities could account for and assess aggregate health effects to multiple contaminants from multiple sources, which are often subject to multiple permitting schemes, but cumulatively impacting the same receptor neighborhoods;

- Provide the necessary level of detailed information to prioritize, and simultaneously begin identifying potential solutions, for sources resulting in unacceptable risks by estimating combined health effects resulting from multiple contaminants and sources, but at a community level of resolution that is specific to definable individual locations, and generated in a fully transparent fashion such that aggregate risk levels are completely traceable to each contaminant, each pathway, and each source;

- Calculate and track risks from literally hundreds of sources and contaminants based on actual emissions data submitted by facilities to the state agency, and as new or refined data becomes available, it can be directly incorporated into the assessment to obtain revised risk estimates on practically a real time basis;

- Serve as a versatile and dynamic project platform, allowing for the rapid identification, characterization, assessment, and management of aggregate environmental exposures that pose the greatest health risks to the public.

IV. Uses of Modeling and Monitoring

1. North Little Rock, Arkansas: Modeling was used to evaluate chronic exposure at the site. Monitoring was used in conjunction with modeling to select locations to evaluate acute exposure at the site.

2. Calcasieu, Louisiana: Modeling used to cite monitors and track emissions which exceed state standards to their sources of origin.

3. Port Neches, Texas: Canister monitors had identified the area as a chronic exposure problem for over ten years. Mobile monitoring verified the canister results and also indicated acute exposure problems. Modeling was used to track measured emissions back to their source(s). A monitoring to modeling study conducted with this study revealed data gaps associated with the emissions inventory for both source location and estimated emission rates. Also,

uncertainties were found to be associated with both monitoring and modeling. The magnitude of the effects of data gaps and uncertainties was found to be chemical- and site-specific. When data gaps were filled for two of the major chemicals emitted in the area, modeling to monitoring comparisons were within 15% of each other.

V. Key results

Major program changes for which specific, immediate benefits of the application of the RAIMI include:

1. Prioritization of resources based on the contribution to human health risk (management of "worst first")
2. Improved community outreach and involvement by allowing citizens access to more comprehensive environmental analysis
3. Objective, scientific basis for evaluating new facility sitings, operational modifications and plant expansions

The RAIMI studies completed to date have focused on evaluation of volatile organic compounds released to the air over three specific communities. Data generated from application of the RAIMI facilitated regulatory decisions that focused on environmental benefits.

1. North Little Rock, Arkansas, had a history of citizen complaints surrounding a creosote plant.

    - One facility, multiple emission sources
    - No significant potential health impacts identified
    - Odor problem existed, naphthalene identified
    - Based on modeling, State elected not to pursue additional permit requirements.

2. Calcasieu, Louisiana had been identified by the National Environmental Justice Advisory Committee as an area of high concern. The Agency of Toxic Substances Disease Registry had measured dioxin levels above background in residents' blood.

    - 18 major facilities, 2500 point sources
    - RAIMI modeling used to validate placement of air monitors and to track excessive monitored air pollution back to individual sources.

3. Port Neches, Texas had excessively high monitored concentrations of air pollutants dating back over 10 years.

   - 16 major facilities, 1500 point sources
   - RAIMI modeling used to locate specific emission source(s) that resulted in excessive monitored air toxics. Prioritization of permitting and enforcement actions was narrowed to focus on two facilities and three individual sources.

VI. Lessons Learned

A review of the design goals at the end of the Pilot Study indicates that design goals were substantially achieved as RAIMI provided:

- A flexible mechanism to consider a range of risk management alternatives to ensure protectiveness;
- A standardized and consistent means to prioritize sources based on risk impacts;
- A sound methodology ensuring that each elemental component of risk or modeled air concentration is fully traceable to the culpable source; and
- The flexibility to be revised as new or more complete emissions data sets become available.

Certain of these design goals could be more fully achieved, however, given the following:

- Emissions inventories that are more complete, particularly with regard to emissions speciation, and inclusion of emissions from minor sources, would significantly increase confidence in results;
- Data management tools could be developed and incorporated into the RAIMI approach to improve the ability to access, compare, manipulate and revise data among the emissions characterization data sets, air dispersion modeling results and risk modeling results;
- Aspects of the technical approach can be modified to reduce the amount of extraneous data generated.

10. San Francisco Bay Area

I. Project Name and Location, Project Sponsor, Brief Overview

Characterization of Urban Air Toxics Sources in Support of HAPs Emission Control Strategies. Location: SRI International, Menlo Park, CA. Sponsor: EPA Office of Research and Development, National Center for Environmental Research, under STAR grant R827927, Deran Pashyan COTR.

II. Contact Name and Information

Dr. Michael J. Coggiola, SRI International, Menlo Park, CA, 650-859-3045,
michael.coggiola@sri.com

III. Key Questions Addressed and Purpose of the Project

This research program leverages SRI's development of a continuous emissions monitor (CEM) for dioxins and furans supported by the U.S. Department of Energy (DOE). The detector uses a pulsed nozzle gas inlet, resonance enhanced multiphoton ionization (REMPI), and time-of-flight mass spectrometry (TOF-MS). Using this Jet-REMPI approach, detection limits in the low 20 parts-per-trillion have been obtained. The extreme sensitivity and chemical specificity of this instrument, and the nearly universal nature of REMPI and mass spectrometry, provide a new analytical capability. With a single instrument, the spatial and temporal distribution of a majority of the most toxic organic HAPs can now be concurrently measured at levels that are of toxicological interest.

IV. Uses of Modeling and Monitoring

This instrument will provide direct detection and identification of the most HAPs and HAP mixtures in urban air in real time, i.e. one to several minutes of averaging. The objectives in this combined laboratory and pilot field study are to establish a viable means of measuring the emission rates, and temporal and spatial distributions of urban air toxics and HAPs using our ultra-sensitive CEM. Because our CEM is capable of directly measuring in real-time the concentration of specific HAPs and urban air toxics at levels far below present analytical instruments, we can potentially identify and characterize critical emission sources over a wide geographical area under a variety of ambient monitoring conditions.

V. Key Results

SRI's spectral library now includes more than 120 compounds, including many of the most common urban air toxics. Using this library, we have begun a preliminary local field study by collecting urban air samples onto sorbent tubes for off-line analysis. We anticipate that these analyses will ultimately allow us to not only improve the sampling and analysis protocols, but also to establish some approximate air toxics levels in the San Francisco Bay Area. This latter

data will permit us to determine if our current instrumental sensitivity is sufficient for real-time field measurements, or if further improvements will be required to acquire this type of field data.

To test our sampling and analysis approach, samples were taken from a variety of sources, including automobile exhaust, and ambient air. In ambient air, we collected samples on a carbon filter element for 3.5 hours, to obtain enough sample to use GC/MS as a survey tool. Only toluene shows in the GC/MS scan as a small signal. To use Jet-REMPI, we diluted the same sample by a factor of 20,000 to avoid overloading the instrument. This dilution is equivalent to a direct measurement with a sampling time of about 1 sec. All of the BETX (benzene, toluene, ethyl benzene, and the xylenes) compounds were readily seen in the Jet-REMPI instrument, and the three isomers of xylene could be individually quantified. Our preliminary study showed that not only can many urban air pollutants, such as BETX, be detected quantitatively using Jet-REMPI combined with long-term sorbent sampling, but more importantly, because of the high sensitivity of REMPI, these same compounds could also be detected in the field in near real-time without preconcentration.

In parallel with the urban air sampling effort, we have also performed a pseudo-field study with support from the Department of Energy. SRI had a unique opportunity to perform a series of pseudo-field measurements without the time and expense associated with transporting the instrument to a field site. This was possible by using the REMPI apparatus that SRI built for Dr. Brian Gullett at the EPA's NRMRL. Since that apparatus is essentially a duplicate of the one currently in use at SRI, measurements taken with the system in conjunction with EPA's combustion facility allowed us to make these "field-like" measurements. Among the most intriguing observations was the detection of several interesting species that were identified in a nominally "clean" methane flame. Benzene and phenol (at 150 ppt) were both positively detected in the off-gas stream of the reactor. In addition, clear evidence was also found for aniline produced in the EPA reactor under the test conditions. For all species, the measured spectra are essentially identical to those recorded using a "clean" test gas mixture and all were easily detected in the exhaust stream. Furthermore, their presence could be entirely attributed to the methane combustion chemistry as the background levels were not detectable in the absence of the flame.

This study further demonstrated the usefulness of Jet-REMPI for rapidly detecting and identifying organic species at trace levels under "field-like" operating conditions.

VI. Lessons Learned

There are several important lessons learned from both of these simple studies. It seems clear that our new analytical method is very well suited to measuring air toxics with high temporal and spatial resolution. Our current instrument, however, is much too large and bulky to take to the field. In addition, it is clear that more effort is required to develop a direct air sampling inlet suitable for field studies. SRI is currently pursing the development of a more compact Jet-REMPI system based on a variety of commercial components, including fixed frequency and broadband tunable laser systems, and compact time-of-flight mass spectrometers. Once developed, such a system could be very useful in field studies of urban air toxics.

11. South Coast Air Quality Management District, CA

I. Project Name and Location, Project Sponsor, Brief Overview

Multiple Air Toxics Exposure Study (MATES-II) in the South Coast Air Basin of California.

II. Contact Name and Information

Mike Nazemi - South Coast Air Quality Management District (SCAQMD)
mnazemi@aqmd.gov

http://www.aqmd.gov/matesiidf/matestoc.htm
http://www.aqmd.gov/matesiidf/chapter2.doc
http://www.epa.gov/ttn/chief/conference/ei10/toxics/nazemitoxics.pdf

III. Key Questions Addressed and Purpose of the Project

This was a Environmental Justice (EJ) study involving many stakeholders.

IV. Uses of Modeling and Monitoring

Four Counties (several 1000 sq km); modeling was done at a local scale as well**.** Two of the three neighborhoods were about 4 km squares; the third was about a 2-3 km square.

V. Key results

There were three main components: Monitoring; Emission Inventory Development; and Modeling. The monitoring effort was an enhancement of existing South Coast monitoring in the area (increase in number of sites and sampling frequency). Monitoring spread across a four county region from April 1998 - March 1999. Looked at 30 plus pollutants.

Monitoring networks were not dense enough to answer EJ issues or provide culpability. Thus they supplemented with modeling. First developed a detailed emissions inventory. Modeled study area with Urban Airshed Model (UAM) at a 2km resolution. Also did microscale modeling using ISCST3. Study showed diesel PM (DPM) was biggest health concern for air toxics. Also looked at results without DPM.

VI. Lessons Learned

The biggest lesson appeared to be one of communication issues with the many stakeholders involved; especially as the project wound down.

12. Barrio Logan, San Diego, California

I. Project Name and Location, Project Sponsor, Brief Overview

Project Name: Barrio Logan

Project Location: San Diego, California

Project Sponsor: California Air Resources Board

II. Contact Name and Information

Linda Murchison, Ph.D.,
Assistant Division Chief
Planning and Technical Support Division
California Air Resources Board
1001 I St., PO Box 2815
Sacramento, CA 95812
(916) 322-5350
lmurchis@arb.ca.gov

The Barrio Logan Pilot Study was developed to address concerns about air quality in a predominantly minority and low-income community in San Diego, and to begin to develop monitoring and modeling protocols for evaluating environmental justice concerns.

The Barrio Logan community of San Diego was selected for study because it is located in a large urban area, near major freeways and industrial sources, as well as neighborhood sources such as gas stations, dry cleaners and automotive repair facilities. In the initial phase of the study, ARB conducted ambient air quality monitoring at the Memorial Academy Charter School. Monitoring began in October 1999 and concluded February 2001. Results from the first six months of data suggested toxic and criteria pollutant concentrations were similar to those measured in other urban areas of San Diego. Further analysis on all monitoring results are currently being conducted.

The Barrio Logan Pilot Study is also the first to be conducted for ARB's Neighborhood Assessment Program (NAP). The goals of the NAP are to assess the cumulative impact of air pollution sources on communities and to develop guidelines for evaluating strategies for reducing air pollution impacts at a neighborhood scale. In order to estimate air pollutant concentrations, ARB staff developed an approach using regional (UAM, Models-3) and micro-scale (ISCST3, AERMOD) air quality models to assess ambient and near-field pollutant concentrations. Model results are currently being evaluated using tracer measurements, additional air toxics monitoring, and uncertainty analysis.

EMPACT

AIR MONITORING PROJECTS

From 1998 to 2001, the Environmental Monitoring for Public Access and Community Tracking (EMPACT) Program funded 33 grants to local government agencies (Metro Grants). Metro Grants support locally proposed and managed environmental monitoring and communication projects that emphasize active partnerships between local and state government, research institutions, non-governmental organizations (NGOs), the private sector, and the federal government. Metro Grants receive up to $400,000 in federal funds and are required to contribute a local match to encourage sustainability beyond the federal funding period.

To learn more about other EMPACT projects and to order EMPACT technology transfer handbooks, please visit www.epa.gov/empact. All project abstracts, progress reports and final reports are posted to www.epa.gov/ncer. For more information, you may contact **Madalene Stevens**, EPA Project Officer, at 202-564-2278, stevens.madalene@epa.gov.

The following is a summary of the nine EMPACT Metro Grants conducting air-monitoring programs.

1. AirBeat: Time-Relevant Communication of Ozone and Particulate Air Pollution, A Pilot Project to Raise Awareness and Promote Exposure Reduction - Boston, MA
(Local Contact: Jennifer Charles, JenEnviro@aol.com)
http://airbeat.org/

This project developed and implemented real-time ambient air pollution monitoring and data management techniques for ozone, fine particulate matter ($PM_{2.5}$), black carbon soot (BC), and visibility to allow time-relevant communication of these data to the public in a way that can be readily available, easily understood, applied by members of the community to reduce human exposure, and used to increase public awareness and understanding of pollution sources, health effects, and precautionary measures. These data are targeted to the urbanized Roxbury neighborhood of Boston. This project is the basis for a technology transfer handbook currently being developed.

2. Burlington EcoInfo: Community Based Environmental Monitoring in the Burlington Ecosystem, The Next Step in Building a Sustainable City - Burlington, VT
(Local Contact: Betsy Rosenbluth, brosenbluth@yahoo.com)
http://www.uvm.edu/~empact/

The goal of this project is to engage citizens in developing environmental information accessible to a broad cross-section of residents and to use this information to inform collaborative actions that address priority problems in their urban ecosystem. This is a multi-media project that includes both air and water monitoring data. Hourly ozone measurements are included on the web site.

3. ECOPLEX: Environmental Conditions On-Line for the Dallas-Fort Worth MetroPLEX - Denton, TX
(Local Contact: Kevin Theusen, kevin.thuesen@cityofdenton.com)
http://www.ecoplex.unt.edu/

The goal of this project is to inform citizens of the current, historical, and near-term forecasts of environmental conditions to which they are exposed, including water, land, sun and air. The web site features ozone data and ozone alerts.

4. AirInfoNow - Tucson, AZ
(Local Contact: Beth Gorman, bgorman@deq.co.pima.az.us)
http://www.airinfonow.com/

This project aims to develop a unified approach among the collaborating agencies for environmental data collection, management, reporting, and education using air quality as a pilot medium. The web site reports live air quality index values for PM_{10} and $PM_{2.5}$, ozone, and carbon monoxide, features a web cam visibility photo, and has an extensive education component. The web site, phone hotline, and newsletter are available in both English and Spanish.

5. Paso del Norte Environmental Monitor - El Paso, Texas
(Local Contact: Ricardo Dominguez, rdominguez@elpasompo.org)
Project web site not yet developed. See http://ozonemap.org/ and http://air.utep.edu/ for related sites.

This project is using currently monitored ozone, carbon monoxide and particulates combined with local weather, current traffic conditions and international bridge crossing delays to compile information into a predictive traffic model to be broadcast to the public in order to encourage alternative modes of transportation. This project encompasses the tri-state / bi-national area of El Paso, TX, Sunland Park, NM and Ciudad Juarez, Chihuahua, Mexico and the web site will be presented in both English and Spanish. This project is the basis for a technology transfer handbook currently being developed.

6. The Tulsa Air and Water Quality Information System (TAWQIS) - Tulsa, Oklahoma
(Local Contact: Monica Hamilton, mhamilton@ci.tulsa.ok.us)
http://e-tulsa.org/

This project assists people in the metropolitan community and the surrounding regions of Northeastern Oklahoma connect environmental data to their daily lives and promote public involvement in environmental policy. This objective will be reached by providing environmental information, and public awareness and educational programs. This project includes both air and water monitoring data. The web site features real-time ozone data.

7. Providing Timely Public Access to Daily Air Quality Information About Birmingham, AL and its Regional Environment - Birmingham, Alabama
(Local Contact: Sam Bell, SBell@jcdh.org)
http://vortex.nsstc.uah.edu/empact_bhm/

This project will develop and implement a greatly improved and sustainable program of local air quality monitoring and timely and effective public access to useful information about metro Birmingham as well as regional (southeastern and eastern US) air quality and related meteorology. The public outreach will also include a program for the promotion of public awareness and education about air quality and related health effects. The web site features the current local air quality index; timely ozone, PM_{10}, $PM_{2.5}$, and SO_2 levels; and extensive mapping capabilities.

8. Rapid Mapping for Clean Air in Commerce City - Commerce City, CO
(Local Contact: Lynn Robbio Wagner, wagner@tchd.org)
Project web site not yet developed

This project will demonstrate innovative methods for providing timely reporting of the spatial and temporal distribution of air pollutants in a heavily industrialized urban community. This methodology will utilize data from real-time measurements of meteorological parameters and concentrations of air pollutants, atmospheric dispersion models (ADMs), and a Geographic Information System (GIS) to map the spatial distributions of selected air pollutants.

9. Real-Time Monitoring and Communication of Levels of Fine Particles, Ozone and Black Carbon in Northern Manhattan - New York, New York
(Local Contact: Swati Prakash, Swati@weact.org)
Project web site not yet developed

The primary objective of this project is to develop and implement real-time monitoring, data management, and public communication of ambient levels of fine particulate matter ($PM_{2.5}$), ozone and black carbon soot (BC) in the urbanized Northern Manhattan neighborhoods of Harlem and Washington Heights. The project will use instrumentation that is sensitive to diesel fuel emissions, including an Aetholometer for real-time monitoring of black carbon. Data will be communicated to residents in a way that is accessible, understandable, and can be utilized to reduce their exposure and health risks.

Regional Community Assessment Monitoring and Modeling Studies

This table represents information provided by the regions for the past and on-going air toxics activities which evaluate and address concerns about air toxics at the community level. Some of these activities are only monitoring sites supporting the air toxics monitoring network. Other activities include complete participation by local communities in assessing and addressing the local air toxics concerns. Many of the projects include development of local emission inventories, modeling, and monitoring information. EPA is developing a complete database to be located on the TTN website which will include more detailed information on these air toxics studies.

For additional information, contact:

Barbara Driscoll
Policy, Planning and Standards Group (C439-04)
USEPA/OAQPS/ESD
Tel: 919-541-1051
Fax: 919-541-0942
Email: driscoll.barbara@epa.gov

5/31/02

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Region 1				
Ongoing/Planned				
Merrimack Valley, MA 5 cities/towns	Assessment to identify reduction priorities	Air toxics/Stationary, Mobile, Indoor	Susan Lancey Region 1 617-918-1656 Barbara Driscoll OAQPS 919-541-1051	Review emissions data for use by existing community involvement networks in 5 diverse Merrimack Valley towns to clarify, prioritize, and select the most crucial toxics issues; these will then be addressed for reduction by appropriate interventions and/or regulatory strategies.
New Haven, CT	Toxics Inventory Development	Greenhouse gases and toxics	Mary Beth Smuts/ Barbara Driscoll	Beginning development of emission inventory and local action plan.
Lawrence, MA	Inventory and Modeling	All Sources	Allen Jarrell/ Barbara Driscoll	Project will evaluate whether the cumulative risks due to air pollution (incinerators) contribute to high asthma rates.
Manchester, NH: area around airport	Inventory of sources and emissions (1996)	Air Toxics-All Sources	Bob White-NHDES/Doug Koopman-Air	Evaluation of 7 sq mile urban area will use information to target and conduct inspections.
Manchester, NH-school ongoing	Monitoring-inside and out	VOCs, Particulates and Aldehydes	Rick Rumba-NHDES/Dr. Rosemary Caron	Indoor/outdoor monitoring in school to correlate with asthma records.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Providence, RI	Monitoring (2000 pilot site)		Barbara Morin-RIDEM	One of 10 cities picked for new air toxics monitoring .
Past				
Olneyville, Providence, RI (1990-91)	Monitoring	Air toxics-area sources	Barbara Morin-RIDEM/MSmuts-RegI	Hotspot analysis of jewelry industries in neighborhood.
Chelsea, MA	EPCRA Inventory	Air Toxics- All Sources	Dwight Peavey-EPCRA	Ranked HAPs based on quantity of release and health effects.
Bridgeport, CT (1987-1988)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Springfield/Chicopee MA (1987-1988)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Region 2				
Ongoing/Planned				
Protecting Communities from Toxics, South Camden, NJ	Assessment to identify reduction priorities	Air toxics/Stationary, Mobile	Marlon Gonzales Region 2 212-637-3769 OAQPS contact to be identified; in interim, Barbara Driscoll	Responding to high-exposure area citizens' concerns, an array of inventory, modeling and monitoring tools will be used to characterize risks and to trigger appropriate risk reduction strategies.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Syracuse, NY		Indoor Air		Current study assessing impact of multiple pollutants on indoor environment.
Puerto Rico	Monitoring (2000 pilot site)			One of 10 cities picked for new air toxics monitoring.
Vicinity of World Trade Center, NY	Monitoring	Variety of Air Toxics	John Fileppelli	Monitoring ambient and worker exposure to air toxics at WTC site and near vicinity. Data potentially to be used for future risk assessment.
Past				
Staten Island, NJ (1987-1991)	Ambient and meteorological data collection, indoor air sampling, EI developed	VOCs, PM and Metals	Conrad Simon, Robert Kelly, Rudolph K. Kapichak, Carol Belizzi	Qualitative risk assessment performed for indoor and ambient air. Initiated on citizen complaints.
Region 3				
Ongoing/Planned				
Delaware Air Toxics Assessment Study (DATAS)	Assessment to characterize risk	Air Toxics/Stationary, Mobile	Melik A. Spain Region 3 215-814-2299 Greg Nizich OAQPS 919-541-3078	Development of monitoring network and speciated HAP inventory to integrate with ambient air quality modeling and meteorological components to define regional/local risks.
Baltimore Traffic Study	Regional monitoring site, indoor and personal monitoring	Mobile Sources w/ Indoor Air included, PM, Toxics	OTAQ	Assess mobile source impacts on indoor and outdoor air pollution concentrations of PM and gaseous toxics in a home and school.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
West Virginia site	Monitoring (2000 pilot site)	28 Air Toxics	Ted Erdman	One of 10 cities picked for new air toxics monitoring.
Urban sites and two special studies	Monitoring (2001 pilot sites)	28 Air Toxics	Ted Erdman	Two year data collection for eleven urban sites throughout region and one year data collection in two areas (three monitors/ area).
Philadelphia, PA	Monitoring/Modeling/Risk Estimation	Air Toxics/Stationary, Mobile, Indoor	Ray Chambers, Reg 3 215-814-2061 Greg Nizich, OAQPS 919-541-3078	Uses modeling to better define city's health risks and estimate potential reductions, to inform public and seek government/business support for reduction measures.
Past				
Baltimore Community (1996-2000)	Inventory, ISCST3 model	Air Toxics	Hank Topper with OPPT	Risk based screening w/ results prioritizing chemicals and facilities. Report issued in April 2000.
Chester, PA (1995)	Multi-media risk study (criteria and TRI inventory, ISCST2 and CAL3QHC models used)	Air toxics, surface and groundwater, fish tissue, lead, RCRA/ Superfund facilities, noise, odor	Dianne McNally, Patrick Anderson	Risk assessment based on ambient pollutant concentrations were modeled with ISCST2/CAL3QHC. Recommendations made for lead paint, targeting sources of air emission, and voluntary emission reductions.
Southern Delaware County Air Monitoring Project (1995-2000)	Monitoring and risk assessment	Volatile Toxics, Metals, PM	Ted Erdman (R3) and PADEP	Long-term monitoring project of three sites (Chester, Marcus Hook and Swarthmore).

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Kanawha Valley Toxics Screening Study (July 1987)	Multi-media risk study (point/area inventory and ISCLT modeling) and monitoring	20 Air Toxics, drinking and surface water, haz. waste	Dianne McNally and WVDEP	Recommendations include improving inventory, modeling and monitoring techniques, evaluate non-cancer risks. WV developed toxics regulation to address 14 pollutants.
Pilot Multi-media Environmental Health Characterization Study of South and Southwest Philadelphia (1997)	Inventory evaluation, health and demographic assessment	Air Toxics, drinking and surface water, haz. waste, lead, radon	Len Mangiaracina	Conclusions include automobiles are biggest source of pollution, cancer mortality 40% higher than national rate. Reccos include improving communication between local agencies and community to empower community to make environmental decisions.
An Environmental Characterization of the District of Columbia (1997)	Multi-media inventory evaluation	Air Toxics, criteria pollutants, surface water, haz. waste		Conclusion is that indoor air is primary problem.
Tri-States Initiatve (Kenova, WV)	See description under Region 4		Jeff Burke	
Kanawha Valley, WV		Air Toxics		Data used in EPA, 1995, Summary of Urban Air Toxics Risk Assessment Screening Studies to Support the Urban Area Source Program.
Philadelphia PA		Air Toxics		Data used in EPA, 1995, Summary of Urban Air Toxics Risk Assessment Screening Studies to Support the Urban Area Source Program.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Region 4				
Ongoing/Planned				
Chattanooga, TN	Monitoring	Air Toxics	Vivian Doyle, Region 4	Community Based Environmental Protection Project to assess the effect of air toxics on the Chattanooga Community.
Louisville, KY	Monitoring	Air Toxics	Vivian Doyle, Region 4	Community Based Environmental Protection Project to assess the effect of air toxics on the Rubbertown Community in Louisville.
Mobile, AL	Monitoring, modeling, inventory	Air Toxics	Van Shrieves Region 4	Community Based Environmental Protection Project to assess the effect of air toxics on the community in Mobile County, Alabama.
Charlotte and Mecklenburg County			Chris Stoneman, OAQPS; Lee Page Reg 4 Alan Powell Reg4	Pilot project to test success of concentrated regional environmental dialogue and cooperation in a smaller confined area.
Tampa, FL	Monitoring	Air Toxics	Van Shrieves, Region 4	This is one of the 10 national air toxics monitoring sites under the National Air Toxics Monitoring Program. The information developed under this project, in conjunction with the national data analysis project, will be used to develop a national air toxics monitoring strategy.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Southeast Florida Air Toxics Study (Broward, Dade, and Palm Beach Counties)	Monitoring and inventory	Air Toxics	Van Shrieves, Region 4	Three-county monitoring effort to characterize ambient concentrations of selected air toxics and to develop a comprehensive emissions inventory in southeast Florida.
Piedmont of NC, SC, GA	Monitoring	Air Toxics	Van Shrieves, Region 4	Three-state monitoring effort to characterize ambient concentrations of selected air toxics in rural and smaller cities in the southeast.
Tristate Geographic Initiative, Greenup Industrial Cluster	Monitoring, modeling, and inventory	Air Toxics	Jackie Lewis, Region 3, 4, and 5	Community Based Environmental Protection Project to assess the effect of air toxics on the community in the vicinity of Greenup, KY.
Huntsville, AL	Modeling and inventory	Air Toxics	Leonardo Ceron, Region 4	Update and expand existing hazardous air pollutant inventory. Conduct dispersion modeling to evaluate impact of air toxics on residential areas.
Jacksonville, FL	Monitoring and inventory	Air Toxics	Van Shrieves, Region 4	Operation of six mobile and three stationary monitoring sites. Conduct a comprehensive emissions inventory.
Hinds, Jackson, Harrison, and Lee Counties, MS	Monitoring	Air Toxics	Van Shrieves, Region 4	State monitoring initiative to quantify overall impact of toxics emission sources in areas of high concentration of air toxics.
Knox County, TN	Monitoring	Air Toxics	Van Shrieves, Region 4	Analysis of trace metals from TSP samples in an area of the county's highest particulate concentration.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Jefferson County, KY	Inventory and modeling	Air Toxics	Van Shrieves Region 4	Emissions inventory, dispersion modeling, and risk characterization will be conducted with focus on area and mobile sources.
Mobile, AL	Monitoring (Part of National Estuary Program)	Air Toxics	Thomas Dzomba, Region 4	Collection of data to determine the chemistry of precipitation for monitoring of geographical and temporal long-term trends. Analytes include acidity pH, base cations and mercury. Study is part of the National Atmospheric Deposition/National Trends/ Mercury Deposition Network.
Kingsport, TN	Monitoring	Air Toxics	Van Shrieves, Region 4	Study focusing on air toxics monitoring to characterize air quality.
Nashville, TN	Monitoring	Air Toxics	Van Shrieves, Region 4	Operation of two population oriented monitoring sites to obtain a better understanding of air quality conditions.
South Florida (Everglades, FL)	Monitoring	Air Toxics	John Ackermann, Region 4	Atmospheric transport and deposition studies on mercury including comparisons of methods.
Charlotte, NC	Monitoring	Air Toxics	Van Shrieves, Region 4	Operation of a mobile monitoring lab in order to secure a better understanding of the influence of a large urban center on regional atmospheric mercury, volatile organic, and carbonyl compound levels.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Past				
Tristate Geographic Initiative, Kenova Industrial Cluster	Monitoring, modeling, and inventory	Air Toxics	Jackie Lewis, Region 3, 4, and 5	Community Based Environmental Protection Project to assess the effect of air toxics on the community in the vicinity of Kenova, WV.
Louisville, KY	Monitoring, modeling, inventory	Air Toxics	Van Shrieves, Region 4	Evaluation of potential usage of open path monitoring and meteorological technology to support toxics release inventory.
Augusta, GA	Monitoring, modeling, inventory	Air Toxics- Mercury	Van Shrieves, Region 4; Danny France, SESD	Conducted study to evaluate mercury releases from a chlor-alkali facility. Results from the study were used to set new MACT for this facility category.
Tampa Bay, FL	Monitoring and deposition	Air Toxics	John Ackermann, Region 4	Completed one year atmospheric deposition study of persistent toxics in rainfall.
Atlanta, GA	Monitoring using open path, continuous gas chromatography, and conventional sampling technology. Modeling and emissions inventory.	Air Toxics/Ozone Precursors	Van Shrieves, Region 4; Bob Stevens, OAQPS	Data used by EPA in A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program. Monitoring network and data was a pilot study to help establish the national Photochemical Assessment Monitoring Stations (PAMS) network.
Jacksonville FL (1986-1987)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Region 5				
Ongoing/Planned				
Indianapolis Public School #22 Local Air Risk Assessment and Risk Reduction Project, Indianapolis, IN	Assessment and Reduction	Air toxics/Stationary, Mobile	Randy Robinson Region 5 312-353-6713 Lara Autry OAQPS 919-541-5544	Supplements a more detailed local air toxics risk assessment on a neighborhood and sources surrounding a local public school. Proposal includes a pollution prevention audit of a coking facility, an environmental audit of the public school, and investigates other risk mitigation opportunities.
NATA Point Source Inventory Refinement in RAPCA Jurisdiction, Dayton, OH	Assessment	Air toxics, VOCs/Stationary	Michael Compher Region 5 312-886-5112 Lara Autry OAQPS 919-541-5544	Refine point source inventory to include all sources and enable modeling to locate hotspots, and to select monitoring and risk reduction locations.
Cleveland OH	Inventory/Modeling/Risk Reduction	Indoor, Outdoor and Mobile	Bill Long ORIA , Jack Barnette Reg 5, Janet Cohen OTAQ, Steve Fruh OAQPS	Intended to demonstrate an approach in which local stakeholders, with advice and support from EPA work collaboratively to reduce risks from air toxics in short term while also putting longer-term strategies in place.
Devils Lake, WI	Inventory, modeling	Mercury	Erin White	Characterize atmosphere emissions, transport, deposition, and bioaccumulative interrelationships for TMDL development applications.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Indiana Harbor, IN	Inventory/Modeling/ Monitoring/Risk Assessment	Toxics contained in contaminated sediments	George Bollweg	Characterize community impacts from volatilized dredged toxic sediments.
Detroit, MI	Personal/Indoor air monitoring	Allergens and certain Volatiles	Christopher Saint, ORD	Asthma/Children's Study
Detroit, MI	Monitoring (2000 pilot site)			One of 10 cities picked for new air toxics monitoring.
Chicago IL	Monitoring		Suzanne King, Region 5/ Ellen Wildermann, OAQPS	Cumulative Risk Initiative around airport in Chicago.
Twin Cities, MN	Personal exposure monitoring	Indoor, Outdoor	Michele Palmer	Characterize Risk.
Region-wide	Emissions Inventory development of 189 toxics pollutants	Point, Area, Mobile	Suzanne King	Database available for multiple uses, including atmospheric deposition.
Past				
Flint, MI	Inventoried 21 TRI facilities and 54 facilities from MI inventory. Used ISCL2 dispersion model.	Chemicals released from plant except for NAAQS		Title VI request to evaluate power plant permit. Developed estimate of human health risks resulting from emissions under 1992 permit for Genesee Power Plant, and risks from multiple sources in vicinity. Only considered inhalation.
SE Chicago, IL (1989)	ISCLT and CDM-2 models used.	30 Air Toxins		All point and area sources in an 817 sq mile area were modeled using ISCLT and CDM-2. Greatest risk attributed to coke oven emissions.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
9 Facilities, MI	Applied IRAP model (based on RCRA guidance developed in Region 6)			Selected 9 facilities which were MWCs and WWBs throughout Michigan. Conducted risk assessment and identified cancer and non-cancer risks for inhalation pathway, resident exposure scenario, and subsistence fisherman scenario.
Cook County, IL and Lake County, IN	Used TRI and RAPIDS inventories; hazard ratios from CEP model			Response to TSCA petition to evaluate air permitting process. Hazard screening report covers two counties in two states. Evaluates hazard not risk with toxicity-weighted emission estimates and "hazard ratios" from modeled and outdoor air monitoring data.
Detroit, MI and Windsor, Ontario, Canada (1985-1988)	Inventory and ISCLT3 model	Air Toxics		Developed inventory of emissions and modeled using ISCLT3. Formaldehyde was the largest contributor to cancer risk, next was coke oven emissions, 1,3-butadiene, and carbon tetrachloride.
Minneapolis/St. Paul, MN	Inventory and ISCLT3 for point sources and CDM-2 for area sources	Air Toxics		Developed inventory, modeled and determined cancer risk. Over 61% of risk due to road vehicles.
Columbus, OH (1989)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Lake Michigan Basin (1991)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Columbus and Akron, OH (1987)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Cincinnati, OH (1989 - 1991)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Region 6				
Ongoing/Planned				
Texas OAQPS/Region 6/Texas 4-Area Air Toxics Project Port Neches Port Arthur Texas City El Paso	Vary by area	Vary by area	Ruben Casso, Region 6 Mark Morris, OAQPS	The assessments will focus on State and Federal agency experience to identify roadblocks, needs and potential solutions in assessing and addressing air toxics risk.
Adopt a School Bus Program, TX	Reduction	Air Toxics (diesel PM), PM, NOx/Mobile	Steven Pratt Reg 6 214-665-2140 Jim Blubaugh, OTAQ 202-564-9244 Yvonne Chandler OAQPS 919-541-5627	Replace pre-1977 buses, develop alternative fuel infrastructures and provide PM retrofit for diesel school buses to reduce student exposure to newer diesel PM and NOx.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Louisiana Calcasieu Parish	The enhanced sampling which began in January 2001. For VOCs, a 24-hour average sample will be collected every sixth day for three years. For dioxins, furans, and coplanar PCBs, a 30-day average sample will be collected every other month for one year.	107 different volatile organic compounds (VOCs), dioxins, furans, and coplanar PCBs at five sampling locations throughout the airshed	Region 6 contacts Steve Thompson Sunita Singhvi	EPA Region 6, the Louisiana Department of Environmental Quality and local industry are contributing to an extensive air toxics sampling effort in Calcasieu Parish. A year of sampling has been conducted and an evaluation and report of the latest monitoring data in light of the state ambient air toxics standards will be completed.
Oklahoma Ponca City	Inventory is done by state. Modeling & risk assessment to be conducted by EPA in cooperation with ODEQ.	Refineries	Ruben Casso, Region 6	Local air toxics emissions/impacts/risk assessment in the Ponca City area. Project would also serve to build state capacity (tools, knowledge, ability).
Oklahoma Tulsa	Inventory to be done by state. Modeling & risk assessment to be conducted by EPA in cooperation with ODEQ.	Urban area - mix of stationary/mobile sources	Ruben Casso, Region 6	Potential project based on the results/lessons learned from Ponca City, OK pilot project. The Tulsa area is larger and has more of a mobile source component.
Oklahoma City	Ambient air monitoring study in Oklahoma City in December 2000 and Spring 2001.	Dioxin	Steve Thompson, Region 6	The purpose of the study is to obtain data which may be useful in determining background urban levels of dioxin in the air where no major dioxin emission sources are located.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
New Mexico Corrales, NM	Under discussion Project is likely going to be a 30-day monitoring effort.	To be determined	Ruben Casso, Steve Thompson, Region 6	Citizen complaints alleging health effects from emissions in the area. New Mexico requested Region 6 assistance to help investigate potential levels and impacts of local air toxics near Corrales, NM
Rio Rancho, NM	12 months of ambient monitoring	At least 18 hazardous air pollutants	Mark Sather, Region 6	Small cities air toxics monitoring project with coordinated with stationary and mobile source emission inventory work**.**
Region 6 has 5 sites in the National Dioxin Air Monitoring Network in Arkansas, Oklahoma, and Texas		Dioxin	Steve Thompson Region 6	EPA Region 6 has 5 sites in the national dioxin air monitoring network in Arkansas, Oklahoma, and Texas in cooperation with the state environmental agencies. National Dioxin Air Monitoring Network The data are intended to help determine background dioxin levels where no major dioxin emission sources are located.
Channelview, TX - Community Involvement Joint Effort -EPA and TNRCC and Harris County	Citizen monitoring by tedlar bags and canisters	VOCs	William Rhea- Region 6	An effort to educate citizens on air sampling, air data availability and air program implementation.
LA/TX Voluntary Episodic Release Reduction Project	Episodic Releases	Chemical Industry	Barry Feldman, Region 6	Region 6 worked with selected facilities to voluntarily seek and obtain the reductions in the incidence of, and emissions from, episodic emissions from facility upsets and malfunctions.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Houston Ozone Nonattainment Area	Episodic Releases	VOC	Jim Yarbrough, Region 6	Investigating the feasibility of documenting significant episodic releases of VOC emissions from facility malfunctions/upsets and start-up/shutdowns in the Houston area. This pilot project will seek the cooperation of area stakeholders to help identify, track and document these emissions and their impact on local air quality.
Recent				
Port Neches, TX	Monitoring inventory modeling and risk assessment completed	Local assessment of chemical plant area	Ruben Casso, Jeff Yurk, Region6 Mark Morris, OAQPS	Region 6 initiated study of HON facilities evaluating ways to reduce risk.
North Little Rock/Little Rock, AR	30-day toxics monitoring and risk & health screening	Wood treatment facility	Steve Thompson and Ruben Casso, Region 6	EPA Region 6 and the Agency for Toxics Substances and Disease Registry (ATSDR) provided risk and health screening evaluations, respectively of 30-days of ambient air toxics monitoring data collected by the State of Arkansas around the Koppers' Industries wood treatment facility.
Past				
Houston, TX (1990)	Inventory based on Houston-Galveston ozone SIP, and RAM dispersion model used	Air Toxics		Past monitoring and emission inventory development. Modeled results using traditional approaches (population distributions or land use distribution), compared with GIS.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Texas - Dallas/Fort Worth and Houston/Harris County	Monitoring data and modeling	12 Air Toxics		Asbestos, chromium, benzene, formaldehyde, allyl chloride, acrylonitrile, and ethylene dichloride of concern.
Combustion Facilities	ISCST-3 dispersion model used on a 100 meter grid.		Jeff Yurk, Cynthia Kaleri, Steve Thompson	Evaluated health risks in communities closest to incinerators. Developed a risk-based tool to evaluate these sites. Trace back to large facilities were reductions should be made.
Chambers, Harris, Jefferson, and Orange County, TX (1987-1991)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Baton Rouge, LA (1988-1992)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Region 7				
Ongoing/Planned				
St. Louis, MO	ASPEN model and ambient monitoring data.	Air toxics, VOCs, NOx, PM/Stationary, Mobile, Indoor	Jim Hirtz, Region 7 913-551-7472 Yvonne Johnson, OAQPS 919-541-2798	Improve outdoor monitoring capability and prepare outreach materials providing real-time data on key pollutants (e.g. formaldehyde) and their significance, for the public to use in reducing exposure and in making decisions on reduction strategies. Also monitor formaldehyde indoors, if possible.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Iowa rural monitoring site	Monitoring (2000 pilot site)			One of 10 locations picked for new air toxics monitoring.
Region 8				
Ongoing/Planned				
Denver County	Emission inventory, modeling and monitoring	Air toxics/Stationary, Mobile and Indoor	Victoria L. Parker-Christensen, Reg 8 303-312-6441 Peter Murchie, OAQPS 503-326-6554 Jim Blubaugh, OTAQ 202-564-9244	Initiate implementation phase, based on completed assessment. Analyze existing programs, engage voluntary support to pilot new reduction strategies.
Green Fleets Outreach and Awareness Program Denver, CO	Reduction	Air Toxics (diesel PM), PM/Mobile	Anne-Marie Patrie, Region 8 303-312-6524 Peter Murchie, OAQPS 503-326-6554 Jim Blubaugh, OTAQ 202-564-9244	Reduce diesel emissions by involving public/private fleet owners/operators of both on- and off-road equipment in voluntary education and recognition program.
Colorado	Monitoring (2000 pilot site)			One of 10 cities picked for new air toxics monitoring.
Parchute, Colorado	Risk Assessment	Air Toxics	Lawrence Wapensky	Pilot air toxics risk assessment of natural gas field, dehydration units and other local sources.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Pueblo, Colorado	Monitoring/Modeling/Risk Characterization	Point, Mobile, Air Toxics	Lawrence Wapensky	Characterize and quantify emissions form Rocky Mountain Steel Mill, Comanche power plant, local cement plant, potential incineration of mustard nerve agent at Pueblo Army Depot, mobile, fugitive and growth.
Region 9				
Ongoing/Planned				
West Oakland California Air Toxics/Environmental Justice Funding Proposal, CA	Assessment and reduction	Air Toxics (diesel PM), PM/Mobile	Richard Grow, R9 415-947-4104 JoLynn Collins, OAQPS 919-541-5671 Chad Bailey, OTAQ 734-214-4954	Document traffic/idling diesel truck Port-related traffic patterns and impacts. Inform citizens of available resources, research mitigation options, involve owner/operators.
Henderson, Nevada (Clark County) Air Toxics/ Environmental Justice Funding Proposal, NV	Assessment	Air toxics, PM/ Stationary, Mobile	Roy Ford, Region 9 415-972-3997 Peter Murchie, OAQPS 503-326-6554	Initiate voluntary gaming industry energy efficiency program, with collateral PM reduction, plus air toxic assessments to form basis for program in very rapidly growing county.
Children's Environmental Health Protection Monitoring; Community Health Program: Barrio Logan (SD), CA	Inventory, Modeling, Monitoring, Risk Characterization	Toxics, Diesel PM	CARB Dale Shimp (CARB)	Community level assessment conducted by CARB as part of its overall risk-based program (monitoring completed).

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Children's Environmental Health Protection Monitoring; Community Health Program: Boyle Heights (LA), CA	Inventory, Modeling, Monitoring, Risk Characterization	Toxics, Diesel PM	CARB Dale Shimp (CARB)	Community level assessment conducted by CARB as part of its overall risk based program (expected to complete monitoring in March 2002)
Children's Environmental Health Protection Monitoring; Community Health Program: Wilmington (LA), CA	Inventory, Modeling, Monitoring, Risk Characterization	Toxics, Diesel PM	CARB Dale Shimp (CARB)	Community level assessment conducted by CARB as part of its overall risk based program (expected to complete monitoring in May 2002).
Children's Environmental Health Protection Monitoring; Community Health Program: Crockett (Contra Costa), Fruitvale (Oakland), and Fresno, CA	Inventory, Modeling, Monitoring, Risk Characterization	Toxics, Diesel PM	CARB Dale Shimp (CARB)	Community level assessment to be conducted by CARB as part of its overall risk based program. Expected to start monitoring at Crockett in Oct. 2001, and at Fruitvale in Nov. 2001. Monitoring schedule for Fresno is to be determined.
Maricopa County, AZ	Design a comprehensive inventory and monitoring network	Toxics, PM, VOCs	Doug McDaniel (USEPA R9); Barbara Driscoll (OAQPS)	Joint Air Toxics Assessment Project: collaborative efforts among Tribes, State, County, OAQPS, and R9; special emphasis on three Indian reservations located within the study area; is also one of the six potential project areas for the R9 Air Toxics/EJ Initiative; initial workplan to be developed.
Pearl City, HI	Future work not decided yet. One monitor in place.	PM(currently); toxics to be installed	Roy Ford USEPA R9	R9 Air Toxics/EJ Initiative: one of the six potential project areas; initial scoping; initial workplan to be developed.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Clark County, NV	Area of focus would be Henderson City NV Monitoring and inventory development	Toxics	Ken Israels USEPA R9	R9 Air Toxics/EJ Initiative: one of the six potential project areas; initial scoping completed ; initial workplan to be developed; Working closely with CCAQMD.
SF Bay Area, CA	West Oakland; Richmond (one dioxin monitor)	Toxics	Richard Grow USEPA R9	R9 Air Toxics/EJ Initiative: one of the six potential project areas; continue scoping efforts; draft initial workplan to be developed.
Los Angeles Airport, CA	Initial focus would be on active R9 involvement in current and future studies and activities at LAX	Toxics	Pam Tsai USEPA R9	R9 Air Toxics/EJ Initiative: one of the six potential project areas; initial scoping and data gathering completed; draft initial workplan to be developed.
LA Alameda Corridor, CA	Initial focus on active R9 involvement with Gateway Cities' Diesel Emission Reduction Program; possibly work with CARB in the Wilmington area including Federal Measures at the Ports of LA and Long Beach.	Diesel emissions	Valerie Cooper USEPA R9	R9 Air Toxics/EJ Initiative: continue scoping evaluation (one of the six potential project areas); draft initial workplan to be developed.
LAWA Source Apportionment Study at LAX	Monitoring at LAX and neighboring communities	Toxics and criteria pollutants	Winona Victery/ Pam Tsai USEPA R9	Project is put on hold after Sept. 11; LAWA is seeking funding from EPA.
San Jacinto, CA	Part of the ten cities monitoring pilot project (four urban sites and six rural sites)	Toxics	Sharon Nizich OAQPS	One of the six small city/rural sites selected for the FY2000 national air toxics monitoring pilot project.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Los Angeles, CA	Air sampling in and outside bus	Diesel, PM, CO, N2O, formaldehyde/mobile sources	OTAQ	School bus exposure assessment to quantify in-vehicle, outside vehicle, near vehicle and ambient exposures to diesel exhaust.
Fresno FACES	Indoor and personal sampling, neighborhood monitoring and EPA supersite	PM, toxics, ozone, environmental tobacco smoke, biological agents/indoor	Tracy Hysong CARB	Began in Oct/Nov 2000. Study of the effect of air pollution on 450 asthmatic children. Examines short term effect of daily air pollution on the symptoms, medication use, and lung function of these children and longer-term effect on the progression of asthma. OTAQ adding additional funding to look at mobile hot spots. Expect to have final reports in 2005.
Past				
Flight Path Particulate Fallout Study in the Area of LAX (2000)	Monitoring during weeks of April-May 2000 in Inglewood	Combusted oil soot particles	Henry Hogo SC AQMD	The study was conducted as a follow-up to an earlier study that found abundant combusted oil soot particulates around LAX.
Air Monitoring Study in the Area of LAX (1999)	One-month monitoring in the vicinity of LAX	Air Toxics, Diesel PM	Henry Hogo SC AQMD	The study was conducted to address public concerns about air pollution that may be attributable to LAX operations.
South Coast Air Basin, CA (1998-1999)	Monitoring, emission inventory update, and modeling	Air Toxics	Henry Hogo SC AQMD	Multiple Air Toxics Exposure Study-II; quantify the magnitude of population exposure risk from "existing" sources; monitoring at ten fixed sites and 14 microscale community locations.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Phoenix, Tucson, Casa Grande, and Payson, AZ (1994-1995)	Monitored for a year in residential back yards, Atmospheric Simulation Model used	Air Toxics		Monitored and modeled air toxics in residential areas. 1,3-butadiene, benzene, formaldehyde, arsenic, carbon tetrachloride, acetaldehyde, and chloroform greatest risk.
Los Angeles CA (1995-1998)	3 monitors in Los Angeles County	10 Air Toxics		Average concentrations compared with 1 in a million cancer risks. Most of risk due to 1,3-butadiene, formaldehyde, and benzene.
Contra Costa CA (1985)	Inventory and modeled using LONGZ	16 Air Toxics		Modeled air concentrations. No health risk assessment done. Highest concentrations were methylene chloride, formaldehyde, benzene, and perchloroethylene.
San Francisco CA (1987-1993)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program
South Coast CA (1986-1993)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Southern CA (1987-1989)		Air Toxics		Data used in EPA, 1994, A Screening Analysis of Ambient Monitoring Data for the Urban Area Source Program.
Santa Clara CA		Air Toxics		Data used in EPA, 1995, Summary of Urban Air Toxics Risk Assessment Screening Studies to Support the Urban Area Source Program.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Region 10				
Ongoing/Planned				
Regional Scale Air Dispersion Modeling for Hazardous and Toxic Air Pollutants in the Treasure Valley, Boise, ID	Assessment	Air Toxics/Stationary, Mobile	Brook Madrone, R10 206-553-1814 Peter Murchie, OAQPS 503-326-6554	Develop regional scale modeling capacity of Idaho DEQ's new Monitoring, Modeling and Emission Inventory group, using more technologically refined tools transferred from WA, to measure Treasure Valley HAP.
Assessment of Emission Inventories and Exposure of Air Toxics Using an Automated Grid Modeling System	Assessment	Air Toxics, PM, VOCs/ Stationary, Mobile	Brook Madrone, R10 206-553-1814 Peter Murchie, OAQPS 503-326-6554	Expand automated air modeling system to include metropolitan Seattle and Portland, and also provide technology transfer assistance in use of the system to Idaho.
Portland, OR	Inventory/Modeling/ Monitoring	Urban Air Toxics and diesel PM	Paul Koproski, Brook Madrone, Peter Murchie ODEQ/USEPA	Study will use 96/99 NTI and additional monitoring data to characterize localized risk information and identify/prioritize reduction management options. Will also provide information needed for State risk based air toxics program development (regulation development).
Seattle, WA	Monitoring (2000 pilot site)		Brook Madrone	One of 10 cities picked for new air toxics monitoring.
Anchorage, AK (statewide) http://www.state.ak.us/dec/dawq/aqi/toxicstrategy.htm	Inventory development, monitoring	Benzene/ Indoors and Ambient	Alaska Department of Environmental Conservation	Looking at benzene and other pollutants, indoors and out.

Location	Monitoring/Inventory/ Modeling	Pollutants/Sectors	Region Lead/ OAQPS Contact	Description
Past				
Tacoma, WA				
Bellingham, WA	Ambient and stack monitoring			Ambient and stack monitoring of an incinerator in Bellingham. Incinerator shut down in the 90s.
Port Angeles				EPA and state conducted series of studies to try and determine why asthma rates were 6 times higher than expected.
Seattle, WA		Air Toxics		Data used in Radian Corp. 1995, Model City HAP Analysis Memorandum